Marine Mammals Ashore

A Field Guide for Strandings

Second Edition

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For

David J. St. Aubin —

Scientist, colleague and friend.

Contents

Preface

Marine mammals have foundered ashore for centuries, but only in the past few decades have we begun to understand the reasons why. The unprecedented die-offs affecting some North American and European marine mammal populations in the late 1980s and early 1990s fueled already mounting concerns about the health of our oceans. The NOAA National Marine Fisheries Service Office of Protected Resources, the agency responsible for protecting and managing most marine mammal species in U.S. waters, was the driving force behind the first edition of this book, published in 1993. The goal then was to provide the rapidly growing volunteer stranding response networks in the U.S. with a practical manual containing basic guidelines for collecting data and specimens from stranded animals and carcasses.

Like the first edition, this book is intended for persons planning to become involved and for those already active in stranding programs. Chapters on historical perspectives and organization show that what one can accomplish alone, an organized team can do faster, more safely, and with better results. The book takes the reader through a spectrum of options for dealing with stranded animals of each major group (pinnipeds, cetaceans, manatees, and sea otters) from the first approach on the beach, to immediate release or rehabilitation, to euthanasia for those beyond hope. A comprehensive plan is offered for gathering scientifically valuable specimens and data from animals, living or dead. Throughout, we take into account the right of the public to witness and become involved in stranding response operations, and the importance of using these events to raise awareness about network activities, marine mammals, and ocean health.

Some topics are touched upon briefly. Although the text describes some clinical techniques and medical conditions requiring emergency care, and ways to transport animals, we deliberately avoid any attempt to teach procedures that must be left to qualified personnel. The sections on rehabilitation present only an overview of husbandry programs. These are written less for the care-giver than for the person on the beach who wishes to know what happens once the animal is taken to a facility—and for the volunteers who may need a more realistic perspective on the complexities and costs of rehabilitation. Such topics as life history and mortality have been covered more or less concisely, with emphasis on natural and human-related processes that play a role in stranding events. We provide greater detail in this edition on infectious diseases (including zoonoses) and unusual mortality events. This information—much of which was gained in the past 10 to 15 years—is intended to encourage a better understanding of the potential causes of strandings, the implications for population and ecosystem health, and possible risks to personal and public health and safety. As stranding networks play a growing role in public education, participants have a new responsibility to provide factual, objective information, and work together to develop consistent and effective messages.

Recognizing that marine mammal movements and habitats are not constrained by national boundaries, we have attempted to broaden the geographic scope of this edition by including information relevant to other areas of North America. The coverage is admittedly thin but might help to further encourage international cooperation, particularly regarding border-straddling stocks. Much of the book's content, however, should be of value for any stranding network, regardless of geography or politics, as it reflects the knowledge and experience of experts from around the world. The section on specimen and data collection has been updated to include additional information on evaluating human-related injuries and unusual mortality events, issues of global concern. We also touch upon advanced diagnostic methods and molecular studies, which will likely continue to transform the way we collect, handle, and analyze specimens. Still, this chapter is intended more for team members in training and those in supporting roles than for the specialists who have their own protocols and will do the work themselves. The chapter on special topics, contributed by guest authors, provides new perspectives and practical information on disentanglement (by Peter Howorth, Santa Barbara Marine Mammal Center), tagging and monitoring (by Anthony Martin, British Antarctic Survey), and the use of GIS and the Internet for maximizing the quantity and value of the data collected (by Gregory Early, A.I.S., Inc.).

The time has long past when a small manual can satisfy the varied demands of stranding program volunteers, long-term responders, and affiliated scientists. We have tried to maintain a balance between overview and detail, and between simple and technical, in a way that offers the most to the broadest audience, and directs those seeking further information to relevant resources. We searched the literature, used our own experience, and sought advice from more than 50 colleagues to bring this edition up to date. Our choice of reference material was ultimately restricted by the book's small format. We therefore offer as many review articles and general works as possible, with more specialized publications used selectively. The bibliography should provide at least a starting point for anyone wishing to pursue a topic in more depth.

The format of this book is our own and we are entirely responsible for its factual content. We ask the reader to bring any inaccuracies or shortcomings to our attention.

We hope that this field guide offers useful and enjoyable reading in the office, lab, or classroom. But, like the first edition, we hope that it will prove itself a reliable and sturdy companion in the field.

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The first edition of *Marine Mammals Ashore: A Field Guide for Strandings*, published in 1993, grew from a commitment by the late **Nancy Foster** (National Marine Fisheries Service, Office of Protected Resources) to streamline collection of marine mammal tissues for the National Institute of Standards and Technology's (NIST) National Tissue Bank. The field guide, developed with the help of numerous friends and colleagues, proved to be useful for its intended audience—the U.S. stranding networks—and for networks in numerous other countries. With generous support from **Dan Basta** (NOAA/NOS National Marine Sanctuaries Program) and technical assistance from **Tom LaPointe** and **Mike Shelby**, we developed an updated CD-ROM version in 1997 that while informative, was not "field friendly." This second edition was driven largely by continued requests for the book. We offer sincere thanks to numerous **stranding network participants** from many parts of the world for their kind comments and encouragement over the years.

This book retains much of the original content. We thus owe enduring gratitude to NOAA's National Sea Grant College Program and to **Ted Lillestolen** (NOAA/NOS, National Marine Sanctuaries Program), **James Mead** (Smithsonian Institution, Washington, D.C.), and **Stephen Wise** (NIST, Gaithersburg, MD) for their various contributions to that project, and especially to the late **David St. Aubin**.

The strength of the second edition owes much to our panel of reviewers, who freely shared their insights and expertise—some (denoted by the *) for the second time around. Chapters or sections were reviewed by **Jack Ames**, California Department of Fish and Game, Santa Cruz, CA (Ch. 9); **Diana M. Antochiw-Alonzo**, Red de Varamientos, Yucatan (Ch. 2, 6); **James Barnett**, British Divers Marine Life Rescue, London, UK (Ch. 4, 6); ***Peter Best**, Mammal Research Institute, University of Pretoria, South Africa (Ch. 6); ***Robert Bonde**, U.S. Geological Survey, Florida Integrated Science Center, Gainesville, FL (Ch. 8); ***Greg Early**, A.I.S., Inc., New Bedford, MA (Ch. 11, 13, 14); **Ari Friedlander**, Duke University Marine Laboratory, Beaufort, NC (Ch. 13); ***Nick Gales**, Australian Antarctic Division, Kingston, Tasmania (Ch. 2, 13); **Diane Gendron**, Centro Interdisciplinario de Ciencias Marinas, Instituto Politècnico Nacional, La Paz, BCS (Ch. 2); **Frances M.D. Gulland**, The Marine Mammal Center, Sausalito, CA (Ch. 12); **James Harvey**, Moss Landing Marine Laboratories, Moss Landing, CA (Ch. 11); **Peter Howorth**, Santa Barbara Marine Mammal Center, Santa Barbara CA (Ch. 2, 5, 6); **Paul Jepson**, Zoological Society of London, London, UK (Ch. 6, 10); **Andrew Johnson**, Monterey Bay Aquarium, Monterey, CA (Ch. 9, 14); **Deanna Lynch**, U.S. Fish and Wildlife Service, Lacey, WA (Ch. 9); **William McClellan**, University of North Carolina, Wilmington, NC (Ch. 6, 10); **Lena Measures**, Fisheries and Oceans Canada, Mont-Joli, QC (Ch. 5, 10, 12); **Melissa Miller**, California Department of Fish and Game, Santa Cruz, CA (Ch. 9); ***Sally Murphy**, South Carolina Department of Natural Resources,

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Chapter 1
Perspectives on Strandings and Response Programs

1.1. ANIMALS

Early in the evolution of mammals, a variety of forms began to explore the sea as an alternative to living on land. Many of those attempts were unsuccessful, and some varieties came and went without making a lasting mark. Others—muskrats, otters, and seals—have partially adapted, while still preserving vital ties to the shore. The cetaceans (whales and dolphins) and sirenians (manatees and dugongs) alone are completely and only at home in water.

Adjusting to the marine environment required the modification of numerous body systems[6,27]. The proficient divers—pinnipeds and cetaceans—demonstrate a host of anatomic and physiologic adaptations for efficiently acquiring, storing, and utilizing oxygen. Some of the more apparent features include:

- Lungs made firm and "springy" by small coils of cartilage that encircle the airways throughout, permitting the lungs to virtually snap open after a dive
- A large volume of blood that is quite dark owing to its rich supply of oxygen-carrying hemoglobin
- An expansive circulatory system with intriguing reservoirs (thoracic rete in cetaceans, hepatic venous sinus in pinnipeds) for storing blood until it is needed, or for routing it elsewhere
- Muscles that are dark, often nearly black with myoglobin, a pigment that can store extra oxygen for release during long dives.

For overall thermal protection, otters and fur seals depend on a blanket of thick fur. Cetaceans and other pinnipeds rely instead on blubber, a tissue that is mostly fat. By regulating blood circulation, a marine mammal is able to deal with extreme variations in temperature when swimming from the surface to the bottom or from one region to another.

Blubber has other important roles besides providing insulation. The tissue is buoyant and enables the animal to remain at the surface to breathe and rest there without effort. Marine mammals drink little sea water and draw most of their fresh water from food. During fasting, or when prey is scarce, fat from the blubber is released for energy and, like that in a camel's hump, produces crucial fresh water as a by-product. To endow her newborn with precious blubber, a mother hooded

seal will transfer enough fat-rich milk to the pup for it to double its body weight within four days of birth (an average gain of 6.5 kg/day), while losing about 30 kg of blubber herself[4].

As vital, but less obvious, are the adaptations for coping with the demanding nature of the saltwater environment itself. The skin of all marine mammals is impervious to sea water. To achieve this impenetrable state, the epidermis of cetaceans employs extraordinary cells tightly woven into an architecture that is unique among mammals[11]. The adrenal gland's response to stress both in cetaceans and pinnipeds also serves to protect the animals from surrounding sea water. Aldosterone released from the adrenal cortex causes the animal to retain its own salt and water, freeing it from the need to drink any quantity of sea water[34]. By this mechanism, an animal in stress becomes physiologically isolated from the external environment.

These adaptations enable a sea otter, for example, to keep warm in icy waters, a baleen whale to migrate thousands of kilometers over several months while fasting, a sperm whale to breath-hold for hour-long dives to 2,000 meters or more, and a seal pup to begin life with energy reserves in place. However, failure of any vital adaptation can jeopardize the tenuous shield protecting the animal from its environment. For example, an animal that cannot eat for whatever reason becomes thin. With less blubber, it must work harder simply to stay afloat and keep warm, thereby burning more energy which depletes more fat—its only remaining source of nourishment and water. The life-draining spiral can tighten rapidly (Fig. 1.1), with effects that are often seen in animals that strand. Many are emaciated, dehydrated, and exhausted[8,31].

1.2. DEFINING A STRANDED ANIMAL

A "strand" is a beach or land bordering a body of water, and **stranded** is defined as having run aground. The latter term also describes any creature left in a helpless position, such as a marine mammal that falters ashore ill, weak, or simply lost. The expression **mass-stranded**, while not so enshrined in convention, generally refers to a simultaneous stranding of two or more cetaceans of the same species, other than a female and her calf[38].

Unusual mortality events (*see* **2.7.2**) may involve a few animals dying under unusual circumstances, or death on a large scale, i.e., a **die-off**. The latter does not describe the cause of death, the number of species involved, nor whether any animals came ashore, but merely the outcome. Die-offs have resulted from rapidly spreading viral diseases[5,10,18], bacterial[15] and parasitic infections[20], prey depletion associated with climatic anomalies[35], and exposure to algal toxins[12,36], among other causes[13]. Such events can bring hundreds or thousands of animals ashore, but none in the manner that could be called a "mass stranding."

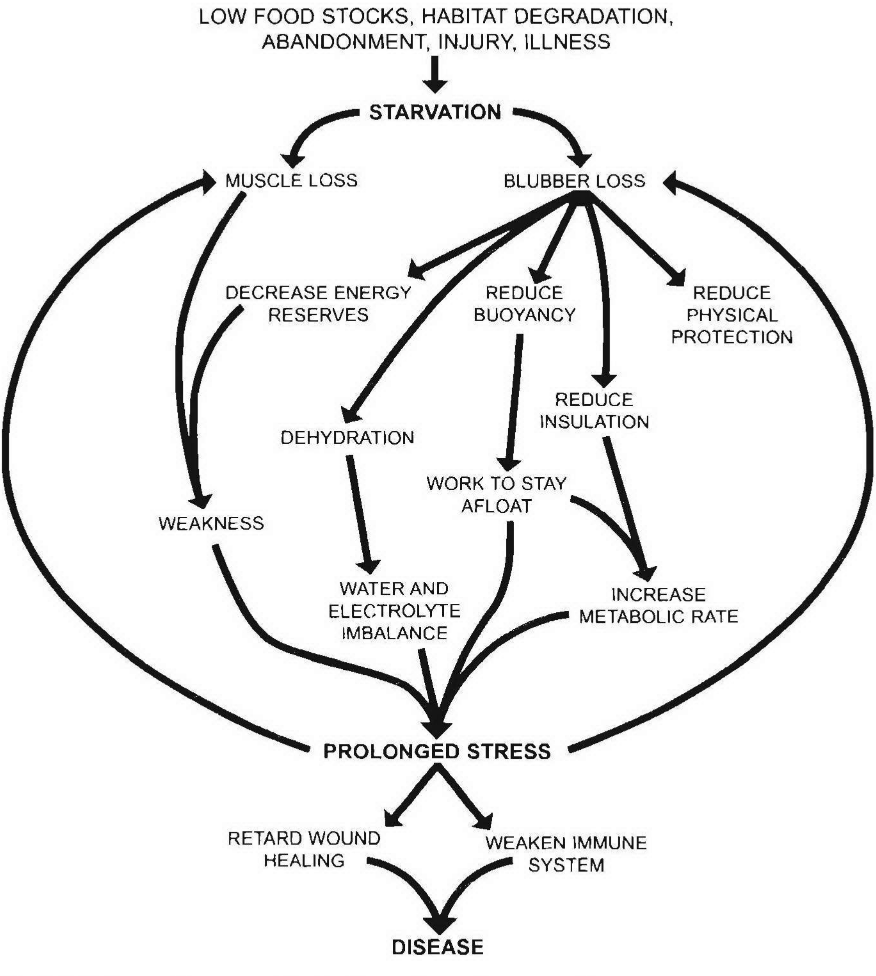

Fig. 1.1. Pathways from starvation to disease in marine mammals.

Since the shore is not the only place where a marine mammal is helpless, a strandling is routinely defined as an animal that cannot cope in its present situation or—borrowing from aviation vocabulary—one that is outside its survival envelope. That includes an arctic seal in Florida waters, a manatee disabled by a vessel strike, an ice-bound gray whale, orphaned dependent offspring, or an otter drenched with oil. This enlarged concept of stranding calls for help as a preventive measure and highlights the quandary of deciding when to act.

Some writers distinguish between strandings and **beachings**, the latter referring to animals cast ashore already dead. For scientific purposes it is useful to adopt that distinction when it can be made, that is, when the animal's condition on arrival is known. Otherwise, the common tendency is to use "stranded" for any live or dead specimen[17,24].

1.3. OF WHAT INTEREST IS A STRANDED ANIMAL?

History is full of references to beached marine mammals. In pre-historic New England and on the Pacific coast, carcasses were used for food and featured prominently in Indian mythology. Maushop, the legendary giant who was said to live on the Massachusetts island of Martha's Vineyard, fished for whales. Those he didn't eat, he cast ashore to share with his friends. Pilgrims later proposed to name what is now Wellfleet Bay on Cape Cod, "Grampus Bay" ("grampus" was a common term for "dolphin") because of the frequency of strandings there. Some of the first laws enacted in the New England Colonies were to establish the ownership of beached whale carcasses.

1.3.1. Serving Science

As the shore developed into a fashionable dwelling place, the occurrence of a seal or whale on a beach must have been a curiosity at best, and at worst a nuisance. But they had value too. Strandings provided some of the first cetaceans for live displays[21], specimens for museums and classrooms, curios for coastal dwellers, and newfound bounty for scientists.

So evident was the scientific potential of stranded animals, that Frederick True, noted cetologist and one of the first curators of the National Museum of Natural History (Smithsonian Institution), organized a marine mammal stranding program along the East Coast—over a century ago. Through successive marine mammalogists, and particularly since 1972 under the guidance of Curator of Mammals James Mead, the Smithsonian is now regarded not only for its traditional collection of marine mammal skulls and skeletons, but also for its archive of photographs, measurements, stomach contents, reproductive organs, teeth for age determination, samples for toxicologic analysis and genetic studies, parasites, and even samples of diseased tissues.

Such efforts worldwide have been rewarded. The existence of some marine mammal species is known only from strandings. Details accumulated over the years have furnished pictures of growth rates, age at maturity, gestation period, birth intervals, reproductive season, and longevity of numerous species[23,33]. We have learned about individual illnesses or deaths as well as large-scale mortalities caused by pathogens, parasites, algal toxins, environmental disturbances, and a wide range of human activities (*see* **5.2**, **6.2**, **8.2**, and **9.2**). Stranded animals give us a running account of the types, levels, and geographic sources of oceanic contaminants[25]. The value to science is unquestioned.

1.3.2. Serving Conservation

How these efforts translate into sound conservation practice is a different matter, one that is gaining the attention of marine mammal scientists, stranding networks, and the conservation and animal welfare communities[32]. Science informs conservation by providing insight into marine mammal populations and their habitats. To the extent we continue to learn from stranded animals, conservation is served. At the same time, delivering rescued animals that were "weeded out" back to sea, some suggest, turns back the clock on conservation and could backfire. For harbor seals in New England, or for California sea lions along the U.S. Pacific coast, the odds are slight that adding one, ten, or even a hundred rehabilitated juveniles will help or improve the host populations. Beyond that is a growing concern that the practice actually could be harmful. Knowing that a common canine virus killed thousands of Baikal and Caspian seals[19], are we rolling the dice on population health by introducing animals that could be carrying an infectious disease agent? As stranding networks and rehabilitation centers continue to grow, and more animals are released, are we placing populations at greater risk? Countering that risk are the vast improvements in husbandry and veterinary care that the same rehabilitation centers are providing. We expect that the numbers of animals released, at least in the U.S., will steadily increase. For conservation to be served, issues regarding the rehabilitation and release of animals from healthy populations must be squarely addressed in conference; if they are not, perspectives will collide on the beach.

The rescue of animals whose populations are in serious trouble is less questioned. The rescue or re-introduction of any healthy monk seal or northern right whale, for example, could have a measurable effect on their very small populations.

1.3.3. Serving Animals and Ourselves

There is much about rescuing a stranded animal that has nothing to do with science, conservation, or ocean health. If these were the only motivations, the next harbor seal to stagger onto a beach would probably be left abandoned. We respond instead because we are moved by the humane need to help an animal in distress. Marine mammals have taken on a new role that is reflected in the way we view them and how we react when any one of them comes ashore. Manatees crippled by boats are a steady reminder of how we indulge our recreational activities at the expense of wildlife. Otters killed by oil expose the growing conflict between our desire to protect fragile coastal ecosystems and our demands on industry to exploit these areas for economic benefit. Any mass stranding of whales is certain to rekindle arguments over the possible role of pollutants, of which the ocean has plenty, or, in recent years, the impacts of anthropogenic noise[7]. Marine mammals, it seems, have become a totem of our battle for a fresh, clean, and undisturbed environment. We search the beaches for evidence of casualties and find stranded animals. We can only speculate on how many are victims of our excesses, but each and every one of them helps us keep the vigil.

1.4. DEVELOPMENT OF STRANDING RESPONSE PROGRAMS

The early literature on strandings consisted mostly of reports of single animals. These accounts, though valuable for their detail, were not integrated into any overall scheme that gave an accurate reflection of stranding patterns and distribution. To be truly valuable, data must be collected in a consistent way, on the greatest possible number of specimens, and over a long period of time. Only then can the information contribute to an understanding of population numbers, shifts, or movements in a population, and factors underlying natural mortality. A unified plan was needed to collect this kind of information.

In the United States, the Marine Mammal Protection Act of 1972 gave the federal government jurisdiction over marine mammals. By protecting them from capture or harassment, and prohibiting the taking of parts from carcasses except by those specifically authorized to do so, the Act was a driving force to organize formal regional stranding response networks.

Initially, scientists working with stranded animals were required to obtain a research permit. But such a requirement was unworkable and meant that research opportunities were missed. Because of these concerns, the U.S. Marine Mammal Commission sponsored a workshop in 1977 at which scientists from 19 states, Canada, and England met to discuss marine mammal strandings. The presentations covered every conceivable topic and generated lively debate on a range of issues that ultimately led to 10 recommendations[9]. One recommendation was to establish the framework for a National Stranding Alert Network with regional centers and a central data file, coordinated by the National Marine Fisheries Service (NMFS).

The workshop served as a springboard for the formation of a U.S. national stranding plan. Centers were organized within each of the NMFS administrative regions, and data were compiled—regionally by member institutions and state agencies, and nationally by NMFS, the Fish and Wildlife Service (FWS), and the Smithsonian Institution.

The Second Marine Mammal Stranding Workshop, held ten years later[28], reviewed the history and achievements of the national plan, region by region, and consolidated a scheme for collecting and archiving data. The range of scientific presentations highlighted the value of using stranded animals to advance our understanding of marine mammal biology from the population to the cellular and molecular levels.

The decade of the 1980s witnessed the expansion of organized stranding programs in other countries as well. From Australia came the "Victorian Whale Rescue Plan"[37], the first step-by-step approach to organizing a civic stranding response. A 1983 workshop on strandings sponsored by the Royal Society for the Prevention of Cruelty to Animals (RSPCA) produced a brief account of first-aid for cetaceans on

the beach[30]. Another manual was prepared in New Zealand for training personnel in marine mammal rescue[2]. The richest popular document of the decade was Frank Robson's book "Strandings: Ways to Save Whales"[29]. It is a splendidly detailed narrative of a retired fisherman's life-long devotion and personal investment in a field few others knew, or cared much about.

What emerged also from the 1980s was an explosion of information, much of it learned from strandings, on mass mortalities associated with infectious agents and toxic marine dinoflagellates. As a response, and to better inform existing stranding networks in the U.S., NMFS established the Working Group on Marine Mammal Unusual Mortality Events (*see* **2.7**). Its purpose is to define criteria for determining what constitutes an unusual mortality event and provide guidance for response and investigation[39]. With mounting evidence linking anthropogenic contaminants to impaired population health, the NMFS Office of Protected Resources also initiated development of the National Marine Mammal Tissue Bank at the National Biomonitoring Specimen Bank (National Institute of Standards and Technology)[3].

The 1990s brought a surge of interest on the effects of various human activities on the health of individual marine mammals and their populations[1,14,22,26]. In the U.S., the Marine Mammal Health and Stranding Response Program, established under the authority of the Marine Mammal Protection Act, was formalized in 1992 to facilitate network activities, enhance consistent collection of specimens and data, and more effectively monitor population and ecosystem health and trends[3].

Stranding networks world-wide continue to grow. With exceptional detail, Gulland et al.[16] provide a country-by-country account (26 countries and regions), including the scope of activities for each network and points of contact.

It is unlikely that any new network will emerge without borrowing extensively from previous thought and experience, much of it summarized by Wilkinson[38]. The goals seem to be universal:

- Provide for the welfare of live animals.
- Minimize risks to public health and safety.
- Utilize strandings as a resource for scientific information.
- Advance public education.
- Enhance the conservation and management of wild populations.

Chapter 2
Getting Organized

2.1. THE STRANDING NETWORK

Stranding networks have **four primary objectives**:

- Provide rapid and effective action that will best serve the well being of the stranded animal(s).
- Protect the public while acting on its concern.
- Gain and disseminate maximum scientific and operational data.
- Protect wild populations.

Essential elements include an emergency response team with a veterinary component; logistic support and equipment for moving live animals and carcasses; a facility for medical treatment and rehabilitation (as feasible or permitted); and a complement of scientists able to provide advice and collect, analyze, and archive specimens and data. To function as a unit, the network requires formal training programs and practice drills, uniform protocols, a spirit of group effort maintained through solid communication, and a clear understanding by participants of their roles and responsibilities.

Stranding networks in the U.S. are nominally based on the administrative regions of NOAA's National Marine Fisheries Service (NMFS). For the purposes of this field guide, it is more practical to establish North American zoogeographic zones based on species distribution and stranding records (Fig. 15.1). The goal is to help predict the types of activity one may expect in a particular area (*see* Chap. 15).

2.2. REGULATORY AUTHORITY

Networks must function within the legal framework established by various federal, state or provincial, and regional authorities. The **U.S. Marine Mammal Protection Act** (MMPA) specifically prohibits the collection of animals (live or dead) or parts from them, or any form of harassment, detention, or restraint, however temporary, without a permit[17]. Exceptions include government officials acting in the course of their duties, and other authorized individuals when the

action is essential to protect the welfare of the animal or the public. The Marine Mammal Health and Stranding Response Program was established in 1992 by Title IV of the MMPA to improve the response to strandings and unusual mortality events. In **Canada**, marine mammals are managed by **Fisheries and Oceans Canada** (FOC) and are protected under the Fisheries Act (amended in 1994), which stipulates that "no person shall disturb a marine mammal..." Subsistence hunting is permitted by native peoples, and commercial hunts are conducted under permit. There are no specific FOC regulations governing rehabilitation: rescue, rehabilitation, and release is permitted in some regions of Canada but not in others due to concerns for health risks to wild populations or endangered species[6]. (FOC regulations are currently under review.) In **Mexico**, federal regulations prohibit moving or collecting marine mammals without a permit. Authorized organizations, such as the stranding network developing through the Mexican Society for Marine Mammal Studies (SOMEMMA)[11], are encouraged to work closely with the **Federal Environmental Protection Agency** (PROFEPA)[5,10]. Within each country, perspectives and resources as well as procedures for reporting and handling stranded specimens tend to vary from one region to another[5].

In the U.S., **NMFS authorization is required for work with cetaceans and all pinnipeds, except the walrus. Walruses, sea otters, and manatees are regulated by the U.S. Fish and Wildlife Service (FWS).** Individual authorization is not always required. One may engage in stranding response activities by joining with persons or institutions already authorized[8]. Organizations or persons authorized by NMFS to respond to pinnipeds and cetaceans may require additional permits to handle animals protected by the U.S. Endangered Species Act (*see* **5.4.1** and **6.4.1**).

Many coastal states in the U.S. have **enforcement officers** with statewide (Marine Patrol, Fish and Game personnel) or local (park rangers) jurisdiction. In some parts of the Pacific Northwest and Alaska, Native American tribes have jurisdiction over specific coastal areas. **Police**, too, have legal authority over many activities on the beach: they can protect animals by limiting public access to the site, erecting barriers, and controlling crowds and vehicles. Police must supervise the use of firearms and may recruit harbormasters or animal control officers to render additional assistance. In Mexico, official duties at a stranding site are the responsibility of the Navy and harbormasters, with local police having little or no involvement.

The **U.S. Coast Guard's** official role in a stranding is limited to minimizing risk to human life or hazards to navigation. With excellent equipment and trained personnel, the Coast Guard often goes far beyond these duties, transporting team members to remote stranding sites, providing foul-weather gear, moving live animals, and hauling beached carcasses to sea under the direction of authorized responders.

Response to oil spills and similar events requires specially trained (i.e., hazardous materials training), authorized personnel. In the U.S., the Coast Guard is the lead federal response agency for spills in marine waters. Animal rescue begins after the spill is contained, and all activities are conducted under the authority of a federal on-scene coordinator and in cooperation with other federal (e.g., FWS or NMFS) and state (e.g., Fish and Game) agencies[1,9,14,15], as well as private organizations and individuals. Regional contingency plans and training are vital for safe and effective operations. For example, the California Department of Fish and Game and the University of California, Davis, School of Veterinary Medicine have collaborated to establish the Oiled Wildlife Care Network (OWCN), which involves more than 25 rehabilitation organizations with facilities and trained personnel prepared for rapid response to oil spills in California[9].

2.3. THE OPERATIONS CENTER

2.3.1. General Considerations

In the U.S., each of the six NMFS regions is served by a regional stranding coordinator and at least one stranding operations center for rescue and rehabilitation activities. Supporting the major centers are satellite facilities (some authorized for carcass recovery or rescue only), which may include aquariums, dedicated rehabilitation centers, research stations, museums, colleges and universities, and state departments of wildlife or conservation. These volunteer networks generally operate under a letter of agreement (LOA) issued by the NMFS regional office. The national coordinator and the regional coordinators oversee and organize stranding response program activities and training.

The basic role of the Operations Center is to provide a continually monitored telephone service (*see* **2.3.2**) for receiving and verifying stranding reports and to coordinate the response. Organizations of potential benefit to the stranding network (e.g., police, Coast Guard, municipal authorities, centers for education and research, and wildlife and conservation groups) should be informed of the Center's existence. The Operations Center has additional responsibilities:

- Organize and administer the regional network.
- Train staff and volunteers.
- Notify and work with federal and local authorities.
- Maintain a communications link among all network elements.
- Promote public awareness of the network's activities.
- Coordinate the response from the Center or closest satellite facility.
- Gather and archive data.
- Report findings to the appropriate government agency.
- Keep track of samples dispersed to authorized individuals.

The Center's effectiveness hinges on local resources and attitudes, which will vary seasonally and among communities. It is unrealistic to expect an enthusiastic response on all holidays or during foul weather. Local officials must be given a plan of action and the logic behind it. Otherwise, they may be tempted to simply push a live animal out to sea, believing they are saving it, or that if it restrands, it will be someone else's problem.

The Operations Center should maintain **up-to-date files** on the capabilities of each coastal community within the region—including physicians or hospitals in the vicinity (for emergency care of staff), beach conditions, and obstacles likely to impede or influence team safety—and plan responses accordingly. The Center's personnel must be aware of any ordinances regulating activities such as carcass dissection (on the beach), disposal, and transport across town or state lines.

Except in areas where the coastline is continuously monitored by wildlife agencies, strandings are usually reported by the public. Each town may have its own delegated or volunteer contact person—perhaps the animal control or conservation officer, harbormaster, or others with a particular interest. When familiarized with the network's program, these liaisons can expedite the stranding response while keeping the community informed. The best approach, however, is for each Operations Center to maintain an effective hotline.

2.3.2. The Hotline

Many Operation Centers have hotlines (dedicated, round-the-clock telephone coverage), some staffed during business hours and others automated with voicemail or an answering machine. Notification of a stranding is the first link in what must be a well-organized system of communication leading to an effective response. For best results:

- **Publicize the number**; make it easy to remember (e.g., 7325 spells "seal;" 94253 spells "whale").
- **Check messages regularly**, and call the reporting party if more information is needed.
- Don't rely on a single individual to monitor the line.
- **Be polite**, professional, and to the point; keep a checklist of information to obtain from the caller.
- Make sure messages can be accessed remotely.
- **Keep the hotline available to callers.** Use another number for peripheral information (e.g., how to volunteer for rescue work).
- **Follow up** with callers when feasible to let them know the results of the response. This fosters good public relations and encourages people to call, volunteer, and remain involved.

When answering a hotline call (or in the recorded message), identify the Operations Center and request the following: name and telephone number of the caller; the animal's exact location (use commonly known landmarks, roads, beaches, headlands, etc.); and a brief description, including type (e.g., seal, sea lion, or dolphin), approximate size and number, and apparent problem, as well as local tide information, sea state, and weather. Do not encourage detailed descriptions: the public is seldom qualified to identify species or specific health conditions. Remind the caller not to touch the animal, and provide an estimated response time if possible. The hotline monitor may request additional information or ask the caller to keep people and dogs away from the animal until help arrives. Once the call is completed, the monitor should make a rapid preliminary assessment, prioritize multiple calls if necessary, and dispatch the rescue team or a local representative. A standardized response form that can be completed for each call is important for collecting and retaining quality information.

To eliminate redundant calls during mass strandings, change the hotline message, alerting callers that the Center has been advised of events (at specific locations) and is taking action.

2.3.3. Liability Issues

Working with stranded marine mammals is dangerous. Each Center must establish its scope of activities (e.g., rehabilitation only, or beach rescues but no water rescues). The decision may be based as much on risk of injury to personnel as on logistic capabilities. Conduct a comprehensive risk assessment of all operations, train and plan for safety (*see* **12.3**), obtain legal advice, ensure that insurance coverage is adequate and current, and have all participants (including those recruited on-site) sign indemnity and release forms. Nonprofit organizations might also consider directors' and officers' insurance. Work with Coast Guard officers, EMTs (emergency medical technicians), and other professionals regarding risk assessment and safety training. Better yet, recruit them as team members. Have a well stocked first-aid kit and personnel with first-aid training on hand during all strandings, and encourage first-aid training among volunteers.

2.4. THE RESPONSE TEAM

2.4.1. Responsibilities

The size, composition, and specific expertise of a response team reflect the type and frequency of animals coming ashore in the region and the resources available to deal with them. Basic responsibilities are the same:

- Monitor the stranding hotline.
- Respond rapidly.
- Maintain communications with the Operations Center.
- Coordinate with local, state (or provincial), and federal authorities.
- Evaluate the situation.
- Take actions necessary for the animals (e.g., first aid, release, transport) while ensuring public health and safety, providing information to the public and media (directly or through the Operations Center), and enlisting local assistance as needed.
- Collect specimens and data.
- Report to the appropriate agency or authorities (directly or through the Operations Center).

2.4.2. Team Organization

Make sure each member knows their role and who's in charge. Develop a clear chain of command. For routine events, the stranding coordinator of the local Operations Center is generally in charge. The stranding coordinator may delegate a response team leader, or perhaps even more than one team (e.g., necropsy team, transport team, beach rescue and water rescue teams, etc.), each with its own leader. A number of teams with similar training may be required to cover a wide geographic range or in situations demanding prolonged work in water or exposure to cold (*see* Chap. 12). Team size is determined by the species, number and distribution of animals, and the beach and weather conditions. An archive of information on the size and composition of teams required under similar conditions in the past will aid future planning.

In some cases, authority for a regional event may extend beyond the local Operations Center. For example, in the U.S., the Coast Guard has ultimate authority over oil spills, while an event (i.e., federal) coordinator may be designated by NMFS or the FWS for an unusual mortality event (*see* **2.7**).

Mass strandings and unusual mortality events often require a far greater level of organization. Teams working in areas where such events are common, or where response activities often involve government or emergency service agencies (e.g., local police or fire departments), should consider response protocols that are compatible with the U.S. National Interagency **Incident Command System**. The

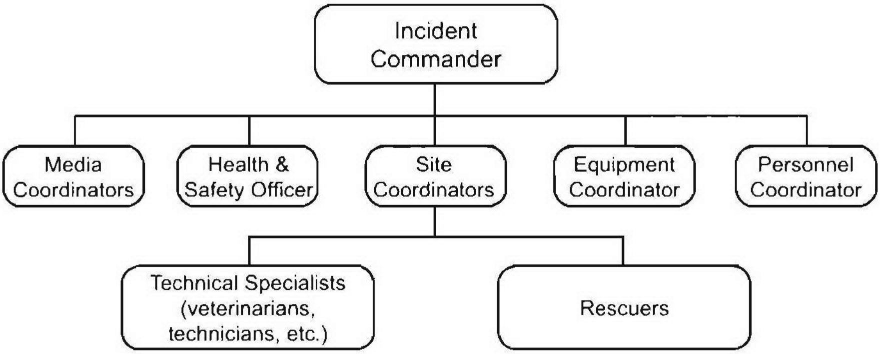

Fig. 2.1. Mass stranding incident command roles[13].

system, developed by fire fighters, allows personnel from various agencies to join forces on site, with pre-established roles and lines of authority (Fig. 2.1). This approach is used for all mass strandings in New Zealand[7] and is being adopted in the U.S.[13]. A single Incident Commander is responsible for overseeing the entire event—including the activities of individual Site Coordinators—from the designated Operations Base (*see* **2.6.3**).

2.4.3. Recruiting

The core team requires a wide range of expertise. Apart from the obvious priorities (rescue, first aid, euthanasia, necropsy, etc.) is the need to organize others, deal with the public and media, make phone calls, maintain records, run errands, and provide for the comfort of beleaguered colleagues. No individual can perform all these tasks. People differ in their interests, skills, emotional make-up, and philosophical beliefs. **Know your team, utilize their potential, and make sure everyone understands the common goals.**

Experienced personnel can be recruited from aquariums, research stations, veterinary clinics, academic institutions, and wildlife and conservation groups. Considerations include academic background, experience in handling wild animals, professional skills (e.g., public relations, heavy equipment operations), marine experience (e.g., boat operations, diving, surfing), physical condition, and—equally important—the maturity, responsibility, and personality to work as part of a team.

Recruit the most qualified people available—for example, safety officers from agencies that routinely deal with public safety. Qualified professionals are often available during their off-duty hours. Veterinarians may be recruited and specially trained to perform necropsies on an as-available basis.

Another approach is to equip and train government personnel to assist on an as-available basis. Park rangers, fish and game wardens, harbor patrol officers, animal control personnel, and Coast Guard personnel are often happy to help.

Look for creative and unusual opportunities to recruit **volunteers**. Register with a local volunteer clearinghouse to advertise your stranding organization and match interested volunteers to appropriate opportunities. Recruit volunteers from colleges and universities. Internship programs, paid or unpaid, can reward students' hard work and dedication with academic credit and job experience. Some employers have programs to encourage volunteerism among their staff. Many high schools require community service of their students (be careful of additional liability issues for those under legal working age). Docents from wildlife monitoring groups and beach-watch groups make excellent volunteers and are often already knowledgeable about marine mammals. Social clubs and community groups also offer good recruits. Retirees often enjoy helping with day-to-day Operations Center activities.

Other volunteers can be recruited through media releases and public events, such as beach cleanups or simulated stranding drills. Finally, remember that a stranding offers excellent opportunities to educate the public and recruit volunteers. Have fliers or business cards available with the hotline number, information on what the public should do if they encounter a stranded animal, and how they can become involved in your organization (*see* **3.2**).

2.4.4. Training

Training programs can use lectures, audio-visual materials, workshops, demonstrations, and practice drills to develop and maintain essential knowledge and skills in a variety of areas. Make sure training materials are up to date. Topics should include:

- **Operations Center and Network purpose, structure, and history:** including relevant legislation (federal, state/provincial, and local), scope of activities, and position descriptions. Provide an organizational chart that clearly defines responsibilities, contacts, and chain of authority.
- **Area geography and conditions:** including local names of all beach areas. Provide maps with details on property access and local resources.
- **Resources:** e.g., arrangements with regional Coast Guard, harbor patrol officers, park service, fish and game agencies, municipalities, conservation organizations, neighboring Operations Centers, etc.; location and availability of equipment for loan or rental (e.g., boats, trucks, or lighting for night work), laboratory services, etc. Update contact lists frequently. Respect people's privacy: never distribute home or personal phone numbers without permission.

- **Marine mammal biology:** e.g., area species, abundance, distribution, life history, and behavior. Equip team members with a good identification guide.
- **Stranding basics:** e.g., the types of events expected in the area, a review of past events, and causes of regional natural and human-related mortality.
- **Response skills:** e.g., team member responsibilities, basic health assessment, decision-making (*see* Chap. 4), use of communications devices and Global Positioning Systems (GPS), and general field protocols (e.g., measurements and data collection). Provide specialized training for operating vehicles and boats, using capture and handling gear, dissection and sample collection (*see* Chap. 10), and tagging (*see* **13.2**).
- **Safety:** e.g., basic first-aid and written safety protocols (*see* Chap. 12), including the use of personal protective and safety equipment. Provide a list of essential personal gear, such as foul weather gear, gloves, and wetsuits (*see* Box 2.1).
- **Public and media relations:** *see* Chap. 3.
- **Hotline monitoring:** including procedures for checking messages, obtaining further information, and dispatching the rescue team.

Sustain team interest between strandings through periodic workshops, demonstrations, simulated stranding drills, and the distribution of literature and newsletters. **Networks will fall apart without regular communication.** A frequently updated website can be a good place to maintain policies, protocols, handouts, and other training materials. Use passwords to limit access to possibly sensitive material.

Trained team members can offer basic instruction to satellite groups, communities where strandings are frequent, local authorities, and volunteers enlisted at the site. Standardized presentations and handouts can help ensure instruction is consistent.

All strandings require a core team with a high level of skill. Mass strandings, in addition, need auxiliary personnel, not necessarily trained, whose greatest assets are their energy and willingness to cooperate. Their tasks must be clearly defined and supervised. Assign tasks based on training.

2.4.5. Practice Drills

Practice drills are an exercise in getting the team to a given place on time. Review each stage of the response—from the hotline call to filing the disposition report—to check the condition of equipment, test strategies and communications, practice safety measures, and correct deficiencies before problems occur. Game plans can be developed for the types of animals and strandings in the region. An associated activity, such as a beach or highway cleanup, generates positive community and possibly media support.

2.5. LOGISTIC SUPPORT

2.5.1. General Considerations

The Operations Center should maintain a depot of basic equipment for rescue, restraint, transport, dissection and sampling, medical procedures, and supportive care (*see also* Box 2.1). Make sure that personal protective and safety equipment (e.g., hard hats, protective eye wear, flotation devices) meet relevant standards (e.g., U.S. Occupational Safety and Health Administration [OSHA]). Machinery, such as cranes, front-end loaders, boats, and other large items, is often borrowed from sources identified in advance. In areas where strandings (particularly mass strandings) are common, it is best to obtain (ideally through donation) essential large equipment such as trucks, trailers, and boats.

One team member should be responsible for coordinating this effort. At the stranding site, medical, dissecting and marking equipment, and data forms are best secured in a central store supervised by a trained person responsible for their distribution and replenishment. For large events, the Operations Base (*see* **2.6.2**) may serve as a central supply depot.

2.5.2. General Categories of Equipment

Heavy machinery and haulage equipment: obtainable from state, county, and municipal public works departments and private sources (a professional operator or contractor can help with selection). Establish availability and financial responsibility in advance.

Foul-weather gear: all personnel should be equipped with raincoat and coveralls and at least one change of clothing. Wet suits or dry suits can be rented from dive shops (rented suits are not appropriate for use in necropsy or large whale carcass disposal activities!); dry suits are preferred for long exposure in cold water (*see* **12.2.3**); wind-surfing suits are also useful.

Protective clothing: long pants, closed-toed and closed-heeled shoes and boots, layered boots, sunscreen, and insect repellent are necessary to protect responders from animal bites, rough environments, and the weather. If responding to oiled wildlife, additional protective equipment (i.e., approved for protection from hazardous materials) will be necessary.

Rescue and first-aid equipment: the Operations Center should maintain a store of tarpaulins, buckets, shovels, ropes, lights, poles, towels, and sheets. Depending on local stranding patterns, specialized equipment may include animal carriers, nets, herding boards, and slings. Additional supplies might be available from state and local fire, police and public works departments, and military installations.

Medical needs: human and veterinary hospitals and animal shelters may provide medical equipment and supplies, including fluids, administration sets, analgesics, blood-sampling supplies, and euthanasia solutions. A collective of cooperating clinics and practitioners might stockpile supplies. Have basic kits on hand (tailored to regional needs) to expedite response.

Diagnostic equipment: some diagnostic techniques for hematology and blood chemistry can be adapted for the field using compact equipment powered by a small generator. Hand-held blood analyzers (e.g., i-Stat®, i-Stat Corp., East Windsor, NJ) can be useful, although less so in very cold or humid conditions[12]. A cooler is necessary to store blood samples. Local hospitals and veterinary clinics can provide more advanced diagnostic support. Prior arrangements with health professionals and laboratories can facilitate rapid processing of samples to assist with prognoses.

Vehicles: ideally, the Operations Center will have a 4-wheel-drive pick-up truck specially designed for beach response, as well as an enclosed, air-conditioned transport van.

Marine equipment: police, Coast Guard, and commercial and private boat operators often respond to the need for small vessels, weather gear, nets, and radios. Maintain an adequate supply of personal flotation devices.

Power and communications: have mobile telephones, VHF or other two-way radios, and spare batteries or a power source for recharging batteries. In remote areas, a deep-cycle marine battery in a waterproof case is a good source of power; wiring the case with a cigarette lighter plug allows easy use of cellular phones. An antenna can improve reception and transmission. Use dedicated radio frequencies and telephone numbers to eliminate distracting calls.

Team identification: for mass strandings, issue waterproof badges, wristbands, or (ideally) mesh vests color-coded for level of training and responsibility (e.g., team leader, highly or moderately skilled, trained vs. on-site volunteers); include name and institutional affiliation. (Be sensitive in determining level of experience and naming training levels: categorizing volunteers can lead to misunderstandings and loss of support.) For single strandings, a name badge will usually suffice. Provide each person with reflective safety tape or a battery-operated or chemical light for night work. Clothing with the organization logo will help identify legitimate responders (perhaps from multiple agencies or centers).

Dissection and sampling equipment, protocols, data forms, photographic gear: pre-assembled kits for obtaining, marking, and storing samples contain knives, sample bags, waterproof tags and markers, measuring tapes, and data

forms. In a pinch, acquire knives from commercial fishermen and butchers; experienced personnel can make a flensing knife by fixing a machete blade (army surplus) to a long handle.

Animal identification kits for mass strandings contain the following:

- Marking equipment for tagging released animals (tags, tagging gun, and replacement parts) (*see* **13.2**)
- Waterproof pencil and logbooks (available from surveying supply companies)
- Vinyl ribbon, paint sticks, or cattle ear tags in different colors to identify animals for 1) immediate release, 2) rehabilitation, 3) euthanasia, 4) necropsy, and 5) disposal
- Large, visible tags for recording vital information
- Chemical lights (glow or light sticks) for marking animals at night (also useful for marking people at night for safety).

2.5.3. Funding

A stranding network is responsible for financial matters arising from any activities performed under its authority. Some centers are associated with institutions that fully or partially support their programs; others rely on public and/or private support. Funding may thus limit the scope of the Operations Center activity. In the U.S., support for marine mammal rehabilitation and for data and tissue sample collection is competitively available through the **John H. Prescott Marine Mammal Rescue Assistance Grant Program**, which is administered through the NMFS Marine Mammal Health and Stranding Response Program[8]. Part of that same program, the **Marine Mammal Unusual Mortality Event Fund** was developed to reimburse or compensate personnel for specific costs associated with unusual mortality events (*see* **2.7**). Maintain up-to-date, complete financial records to facilitate reimbursement and fundraising. Many grant programs require a matching contribution; volunteer time may qualify.

2.6. A MODEL RESPONSE

Animals in some regions come ashore singly and with predictable regularity, needing only a small team. Large whales and multiple strandings always attract attention and demand skillful organization. A group of ailing sperm whales, for example, may elicit an unmanageable amount of public interest and volunteer assistance—hence the need for a plan.

The response described below is one approach. Each Operations Center will need its own plan, keeping in mind that each stranding is unique, and that basic goals and actions must be tailored to the nature of the event and the resources at hand. Even then, be prepared to adjust the plan on short notice.

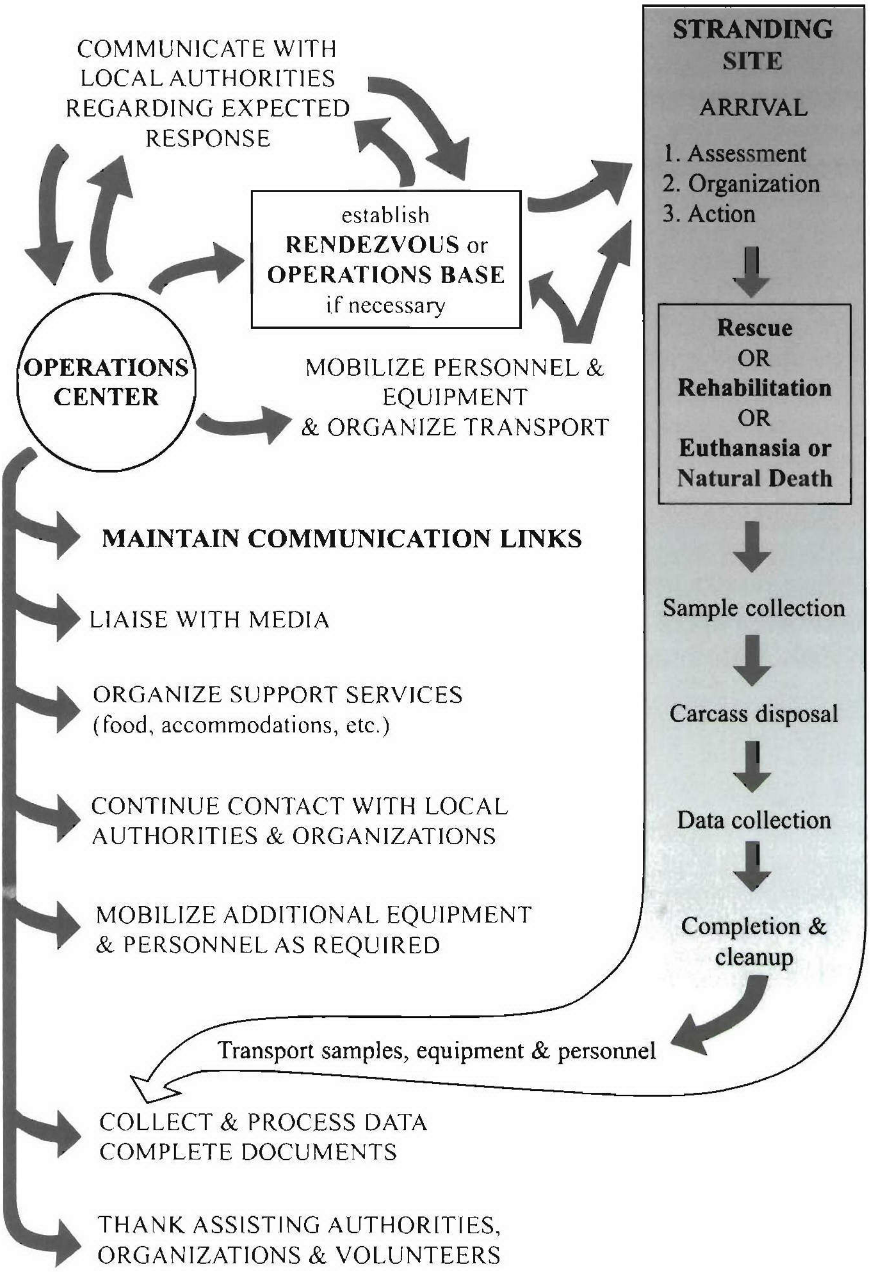

Fig. 2.2. The stranding response.

2.6.1. Organization and Mobilization

The response must be organized and structured, stressing the importance of each assigned task—but always placing **safety first**. Each person rightfully expects to have the resources to get the job done but must respect other overriding needs and keep sight of the common goal.

Rescue teams should be on call during busy seasons, with vehicles and boats loaded with basic equipment and additional gear packed in labeled containers for rapid mobilization. Ideally, pre-pack equipment for hand carrying, and so that it will fit in a standard pick-up truck.

Well-trained teams will generally know the best way to reach most local sites. If necessary, the hotline monitor or Operations Center can obtain further directions while the team is on its way. Check radio stations or highway patrol information numbers and use alternate routes to avoid heavy traffic.

2.6.2. On-site Notification and Evaluation

The Operations Center may immediately dispatch a team or request a network representative/volunteer close to the scene to verify the stranding report and obtain additional information. Once on site, the team (or representative) should notify local authorities of their arrival, identify key contact personnel, and conduct a **preliminary evaluation**, which may include:

- Species, size(s), age class(es), and number of animals (number of dead, number in surf zone, number of "high and dry")
- Animal condition (e.g., body condition, responsiveness, vocalization, behavior, respiration rate, mucous membrane color, temperature, and signs of human interaction); note obvious problems such as wounds or injuries, respiratory distress, or seizures
- Probable action (e.g., rescue, first aid, immediate release, or euthanasia)
- Personnel safety issues
- Weather and sea conditions and state of tide
- Exact location, including landmarks (use GPS for remote or unnamed locations)
- Need for additional resources, if any
- Potential complications (e.g., crowded public beach, sensitive or protected habitat)
- Time required for response (e.g., can it be done before nightfall; if not, is a nighttime response feasible and safe?).

This information will determine the next step: whether intervention is necessary and, if so, the appropriate options (*see* Chap. 4). The Operations Center may then dispatch additional support, drawing upon its own reserves and those of neighboring networks, as necessary.

Certain events may warrant notification of agencies outside the stranding network. Strandings that may be linked to harmful algal blooms, anthropogenic contaminants, or disease potentially transmissible to humans should be reported to relevant local, state, or federal agencies (e.g., in the U.S., NOAA's Marine Biotoxin Program or local seafood monitoring programs, the Environmental Protection Agency, or Centers for Disease Control, respectively). Depending on the circumstances, these agencies may coordinate sample and data collection (*see* **2.7.3**). Enforcement agencies (e.g., NOAA Office of Law Enforcement) should be notified of strandings caused by human interaction, such as gunshot or by-catch.

Large events drawing support from outside the area, or strandings in remote or difficult-to-find locations, may require special arrangements for mobilizing incoming personnel. One approach is to establish a rendezvous point, or Operations Base, at or near the site with continuously monitored telephone service (perhaps a police or Coast Guard station), restrooms, parking, and electrical supply. This is particularly important for remote sites, where final access to the beach might require 4-wheel-drive vehicles and local knowledge of unpaved roads or tracks, or for large events involving multiple sites. Badges previously issued to network members will help law enforcement officers identify persons allowed access to controlled areas. Arriving workers can be briefed and assigned to a team before going to the stranding site. **Provide clear directions, and detailed maps if necessary.** A designated parking area will help avoid traffic congestion and damage to the beach. Transportation to and from the site can be by scheduled shuttle or available on demand, assuming communication is adequate.

2.6.3. On-site Organization and Response

For most events, the site coordinator will brief the team on the appropriate actions and strategy (e.g., capture, first aid, or necropsy), including individual roles and relevant safety protocols. The leader will then direct the overall plan and ensure communications with the Operations Center (or Operations Base). Even single strandings may require the site coordinator to delegate responsibility for certain aspects of the response (e.g., communications with the Operations Center, contact with media, and crowd control).

In the U.S., die-offs and mass strandings are reported immediately to the appropriate federal agency, which may appoint a federal coordinator to oversee response and investigation (*see* **2.7.3**). Large-scale events require relief crews, significant additional resources, and coordinators for each of the main functions

(e.g., veterinary care and support, equipment access/community liaison, media support, specimen and data collection, volunteer organization, and staff support and safety).

The media and public relations coordinator may designate areas for media representatives and the public to gather for periodic updates (*see* Chap. 3). Specimen and data coordinators maintain the supply of dissecting and sampling equipment and data forms, monitor procedures to ensure adherence to protocols, keep track of samples processed in field laboratories or off-site facilities, and collect and organize completed forms and materials (*see* Chap. 10).

A large response requires considerable on-site administrative work. The coordinator of volunteers organizes support staff, keeps records of participants and their affiliations, maintains a check-in/check-out system, and (with the safety coordinator) schedules and supervises revolving shifts. The safety coordinator enforces safety protocols, records injuries and ensures their treatment, and follows up any complications (*see* Chap. 12).

Fig. 2.3. Organization at the stranding site includes preparation for crowd control and dealing with the media, as well as task designation among response personnel and on-site volunteers. On a busy public beach, rope or barrier tape can be useful for establishing restricted-entry zones (*see* **3.3.1**).

Human needs are easily neglected at a busy stranding site. Appoint a trained staff support coordinator to arrange for the comfort of all personnel. In a small-scale response, duties may simply involve locating nearby facilities (e.g., bathroom, shower, and telephone) and providing food. For more complex events, a support center must provide first aid, shelter, food and beverages, a portable lavatory, and hot water for washing. A main center might be located at (or near) the rendezvous point, with a smaller one at the stranding site. For responses lasting more than one day, the staff support coordinator should also arrange off-site accommodations for the team. In remote areas, or when conditions are favorable, personnel might be instructed to arrive equipped for several days of camping. When more formal accommodations are required, be sure to familiarize the innkeeper with the nature of the event, the inevitable round-the-clock traffic, cumbersome equipment, and the untidy appearance and unusual odors of the guests.

2.6.4. Reporting

Large events demand a solid line of communication among the Operations Center, the stranding site, and any off-site rendezvous or staging area, whether by radio, cellular phones, or a planned courier system. Periodic, scheduled meetings with the site coordinator help to determine needs, report progress, and boost energy and morale. Meetings of the group coordinators maintain overall organization and set the course for the next day's activities. The site coordinator issues progress reports to the Operations Center (or Operations Base), which responds to requests for support and relays information, as appropriate, to the responsible regulatory agency.

In addition to reporting unusual events, network participants in the U.S. must report all strandings to NMFS, using standardized stranding report forms (*see* Appendix B). The Operations Center must also maintain disposition records for samples or tissues; obtain NMFS approval for transfer of live animals or tissues to other persons or organizations; and retain complete internal files for each case, including check-in forms, health records, and necropsy and laboratory reports. **Ensure the timely collection of essential data** (*see* Chap. 10).

2.6.5. Communication Among Stranding Networks

An effective response program requires good communication between neighboring stranding networks and, in the U.S., between neighboring jurisdictions through communication among the NMFS (or FWS) regional coordinators and the national coordinator. An internet discussion group, or "listserv," can facilitate informal communication among stranding network members. On a broader scale, communication between neighboring countries is necessary when animals strand near national boundaries and may be critical for investigating an unusual mortality event. Long after a response has concluded, returning rehabilitated animals to suitable habitat may involve release in foreign waters. Ideally, cooperative agreements

between networks and government agencies, national and international, will be in place beforehand. Staying informed of developments in neighboring regions is especially vital to the recognition and investigation of unusual events.

2.7. UNUSUAL MORTALITY EVENTS

2.7.1. General Considerations

Die-offs can extend over weeks or months, take place over a broad geographic range, and involve species that are difficult to study[4]. For most events, the cause will not be established at the outset. As the event continues, fears for the entire population, or even other species, may grow quickly. Public health issues may arise, such as potentially transmissible diseases or contamination of commercial food species. **The task of the response team is to determine the cause of the event, assess its impact on the population and implications for ecosystem health, and address public health concerns.** An effective response demands careful organization and continuous cooperation among numerous agencies.

2.7.2. Criteria for Determining an Unusual Mortality Event

Recognizing an unusual mortality event requires knowledge of normal regional stranding patterns. At some point, the local Operations Center must alert the responsible agency that something unusual may be occurring. It is easier to call off action for an event that turns out to be insignificant than to launch a response when a die-off is well underway. In some cases (e.g., a toxic spill threatening an endangered species), intervention may be appropriate before any casualties have occurred.

In the U.S., the local Operations Center must report such events to the Regional (NMFS) or Species (FWS) stranding coordinator, who then notifies the NMFS Office of Protected Resources[2,8]. This agency gathers relevant information and consults the **Working Group on Marine Mammal Unusual Mortality Events (WGMMUME)**, who then advises NMFS or FWS on whether the event should be declared unusual and serves in an advisory capacity once an event has been declared. In these cases, NMFS or FWS is responsible for appointing a (federal) on-site coordinator. The following criteria, used by WGMMUME, may help the Operations Center recognize an unusual event[16]:

- A marked increase in the **number or frequency of strandings** as compared to prior years. (As a practical measure, an increase in strandings over an area or period of time that strains the capacity of the Stranding Network.)
- Animals are stranding at a **time of year** unusual for the area or the species.
- An increase in strandings is occurring in a localized area (possibly suggesting a localized problem), or throughout the geographic range of the species/ population, or is spreading geographically with time.

- The **species, age, or sex composition** of stranded animals is different from what is normally observed in the area at that time of year.
- Stranded animals exhibit similar or **unusual pathologic findings**, or the general physical condition (e.g., blubber thickness) of stranded animals differs from what is normally seen.
- Apart from mortality, associated animals in the wild exhibit **unusual or abnormal behavior**.
- Critically **endangered species** are stranding.

2.7.3. Response and Investigation

In areas where die-offs are likely to occur, a mechanism for rapidly deploying a well-trained response team should be in place. This assumes that 1) a contingency plan exists; 2) the agency responsible for initiating action has been determined; 3) the roles of all collaborating parties are clearly defined; and 4) funding is available. Ideally, each region will have its own plans, based on the kinds of die-offs likely to occur[3,15]. When jurisdiction over an area or species overlaps, more than one agency may be involved. **Each category of event requires a different strategy**: an oil spill plan will emphasize clean-up and rescue, whereas an event of unknown cause will focus on analytical studies.

A large event requires the collaboration of local, regional, and federal agencies; laboratories with expertise in microbiology, pathology, and contaminant and biotoxin analysis; stranding network members and volunteers; and the media, among others. The response team should consist of persons with collective expertise in life history and ecology, clinical medicine, anatomy and pathology, infectious diseases, and toxicology—working together with an experienced team leader. Also important are the support and services of individuals skilled in media relations, personnel management, resource acquisition, and regional oceanography.

Determining the cause of an event requires diligent collection and analysis of vast amounts of data and samples (*see* Chap. 10) and meticulous record-keeping to ensure credibility of the investigation's results. Make sure analyses are conducted by qualified laboratories.

Obtaining information on population effects may require beach and vessel surveys to locate carcasses and identify trends in the overall mortality pattern. Some events may require years of periodic surveys to identify long-term population effects (e.g., the *Exxon Valdez* oil spill [*see* **9.2.2**]).

Investigating the role of ecosystem health in a die-off is even more challenging. This may require water and sediment samples, tissue samples from other species, or analysis of meteorological and oceanographic patterns for weeks to months prior to the event.

Determining potential impacts on public health is a priority. Analysis of fish and shellfish may be necessary if toxins or contaminants are suspected. While the risk of transmissible disease is generally low, anyone handling live animals or carcasses stranding from unknown causes must take strict precautions to prevent infection (*see* Chap. 12), and the public must be urged to avoid contact.

2.7.4. Public Reaction and Presentation of Results

Public interest in die-offs is intense. Pressure from reporters, the public, and government officials for explanations can tempt the team to speculate prematurely, undermining the credibility of the investigation and promoting misconceptions. The response team must rely on a **designated spokesperson** to keep the media informed of all new findings (*see* Chap. 3).

Once the data have been collected and analyzed, key investigators should strive to produce a comprehensive report (*see* Chap. 14). Such documents can provide valuable insight into future, and sometimes past, events.

Box 2.1. Suggested Field Equipment

Animal Relief
Zinc oxide
Blankets and towels
Shovel (to dig pits for fins and tail)
Ice packs (to keep extremities cool)
Tarpaulins
Foam mattresses
Water sprayers
Inflatable rafts/pontoons
Thermal "Space" blankets (for warming or cooling)

Blood and Fluid Sampling
Syringes:
 5, 10, 20, 60 ml disposable
Syringe needles:
 14, 18, 20, 22, 25 gauge bevel tip
 1", 1.5", 2", 3" (2.5, 4, 5, 7.5 cm)
Vacutainer needle holders
Vacutainer needles
Blood tubes:
 Citrate
 EDTA
 Heparin
 Plain
 Microhematocrit
Screw cap vials for plasma/serum
Pasteur pipettes, 6" (15 cm)
Wood application sticks
Pre-soaked alcohol swabs
Flexible tubing (extension sets)
Microscope slides and covers

Buckets (numerous)
For washing, rinsing, carrying specimens and materials
Container for used needles and blades (e.g. plastic bleach bottles)

Check Lists/Protocols
Telephone lists
Equipment
Task outlines (*see* **2.4**)
This field guide
Necropsy and sample collection protocols

Cleaning Supplies
Disinfectant
Brushes
Heavy duty trash or leaf bags

Communication
Mobile phone
Radio
Extra batteries

(*continued*)

Box 2.1. Suggested Field Equipment (*continued*)

Crowd Control/Public Relations
Signs
Marine Mammal Fact Sheets (*see* Fig. 3.1)
Stranding network brochures
Restricted area tape or roping
Stakes

Emergency Medical Supplies
I.V. fluids and infusion sets (droppers, 10 & 60 drop/min.)
Basic diagnostic equipment (e.g., stethoscopes, thermometers)
Stimulants
Tranquilizers
Adrenalin
Steroids

Euthanasia
Customized needles for whales (*see* **6.12**)
Euthanasia solutions
Other euthanasia equipment (*see* **5.11** and **6.12**)

Forceps
4 1/2" (11 cm) tissue
4 1/2" (11 cm) fine splinter
5 1/2" (14 cm) straight Kelly (serrated jaws, box lock joint)
Jeweler's

Gloves
Latex dish gloves
Disposable surgical
Heavy leather or canvas
Powder-free, vinyl (for toxicology)

Hammer and Chisels

Hooks
5 1/2" (14 cm) shank bailing
Long handle logging

Knives
6" (15 cm) blade steel boning
6" (15 cm) titanium

Marking/Labeling
Labels for sample jars
Markable waterproof labels for placing in jars with preserved tissues
Colored plastic tape for animal identification, triage, etc.
String, for attaching labels
Colored zinc sunblock
Waterproof pencils and pens

Measuring Equipment
Tapes, 10 m (30 ft) and 30 m (100 ft) waterproof, non-metallic
Ruler, rigid 12" (30 cm) (to measure blubber thickness)
Calipers

Microbiology
Alcohol, 70 % dilution
Culture vials - bacterial
Culture vials - viral
Swabs, sterile
Bacterial transport medium
Viral transport medium
Spatula and butane lighter, for searing tissue surfaces

Personal
First-aid kit
Sunscreen
Insect repellent
Hand soap & towels
Protective wear ("foul-weather" gear)
Wetsuit, drysuit
Dry bag
Hats and boots
Surgical masks
Disinfectant (Betadine)
Disposable coveralls
Chemical lights ("Cyalumes")
Flashlights, extra batteries and lightbulbs
Refreshments
Team identification

(*continued*)

Box 2.1. Suggested Field Equipment (*continued*)

Recording
Metal clipboards
Waterproof pencils and pens
Data forms
Necropsy forms
Collection protocol forms
Waterproof markers
Camera and film in waterproof carrier

Restraint/Transport/Tagging
Kennels (for immobilizing or transporting small pinnipeds or sea otters)
Nets
Stretchers (for transporting small cetaceans)
Tranquilizer dart pistol (for restraint)
Plastic tags ("Roto tags") and pliers (*see also* Tables 13.1 and 13.2)
Logging chain with hooks or heavy rope (for towing)
Herding boards
Slings or lifting straps

Saws
25" (64 cm) butcher hand saw
12" (30 cm) hacksaw
Spare blades

Scalpel
Handles, sizes 3 & 4
Blades, #10 & #22

Scissors
5 1/2" (14 cm) straight blade operating (sharp and blunt tip)
6" (15 cm) straight blade dissecting (sharp and blunt tip)
7" (18 cm) straight blade doyen (abdominal)

Sharpeners
14" (36 cm) round steel
Oil stones, coarse and fine

Shears
1 1/8" blade cartilage and bone
Long handle pruning

Spring Scales
100 g, 1 kg, 10 kg

Storing/Preserving
Gross preservation:
Formaldehyde, 37% (dilute on-site to a 10% formalin solution)
Histopathology:
10% neutral buffered (NB) formalin
3% glutaraldehyde (*see* **10.11**)
Glycerin (5% and 10%) in 70% ethanol
70% ethanol (*see* **10.8**)
AFA fixative (*see* **10.12**)
20% DMSO in saturated NaCl in vials (*see* **10.8**)
Cooler for sample refrigeration
Ice packs
Jars for organ sample storage
Aluminum foil (for toxicology)
Whirlpack or Zip-Lock 12 x 18" (30 x 46 cm) plastic bags
Heavy duty garbage or leaf bags

Toxicology (For U.S. National Marine Mammal Tissue Bank [NIST])
Titanium forceps & knife
Teflon bags (6 x 8" [15 x 20 cm]) and jars (500 ml)
Teflon coated tongs and forceps

Beyond the Basics
Small generator
Centrifuge and centrifuge tubes
Hand-held blood analyzer
Liquid nitrogen, cryovials, and shipper
Net gun
Portable ultrasound unit

Additional:

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Chapter 3
Public Support and Media Relations

3.1. PUBLIC ATTITUDES

Only a few decades ago, a dead whale on the beach—or even a live one—might have been viewed as a source of food and oil, a curiosity, or merely a nuisance. Today, a beached carcass still holds the scientist's interest, but a live whale or dolphin, or an orphaned seal howling for its mother, is certain to evoke a different response—one that may quickly reach a nationwide audience. While some would leave the animal to a natural death, and others would kill it as they would a rabid dog, the public today more commonly expects that stranded animals will be rescued, rehabilitated, and returned to their natural habitat.

The range of expectations is shaped by education and other first-hand experiences, the media, and regional values. The urban dweller may view a seal pup more as a pet, and the hunter or stockman may regard it with indifference. A maritime community may see the pup as a future threat to its fishing economy, and the scientist as a source of information. These perspectives all converge at the site of a stranding. Here, attitudes can change, and unlikely alliances are forged in the common desire for action. A responsible approach to stranding response must balance human and animal welfare, and scientific investigation, and achieve this with consideration for local or regional resources and perspectives.

3.2. ENLISTING PUBLIC SUPPORT

3.2.1. Recruiting On-Site Volunteers

Effective stranding response relies on a trained corps of volunteers (*see* **2.4**). In some cases, such as mass strandings, the trained team may need additional assistance. Whatever their viewpoint, most individuals at a stranding are prepared to help and will respect a convincing plan and authoritative leadership. With proper instruction, most volunteers can be assigned to teams or supervised tasks. Respect the attitudes of those in the crowd who are sympathetic and supportive but wish no direct involvement. The impression gained from this experience will shape their attitude toward future events.

When more people volunteer than are needed, some criteria for selection are required. Questionnaires concerning experience, abilities, and health limitations will simplify this process. Those with special skills who are ardently determined to help, quick to recognize mistakes in the response effort, and show burning enthusiasm are best engaged as allies. Giving simple tasks to potentially troublesome bystanders can reduce inadvertent—or intentional—interference. When a lengthy operation is expected, ask willing individuals to return for a later shift, and find out where they might be reached in case there is a change in plans.

Respect those volunteering to help, but, unless verified by someone you trust, take their self-described qualifications with a grain of salt. "Marine biologists," "veterinarians," and other "experts" may appear from nowhere at a stranding, and may or may not have experience relevant to the situation.

Do not expect volunteers recruited on-site to have the same dedication that you demand from the trained team, though you may get as much and more. Volunteers may arrive unprepared for field conditions or foul weather, or they may have other obligations that require them to leave before their tasks are complete. For some, the commitment is fragile and weakens when their expectations about their role or contribution are not met.

Assign appropriate tasks to on-site volunteers—carrying equipment, for example, or helping with support activities. Do not allow on-site volunteers to work directly with animals or under hazardous conditions until they sign a waiver (*see* **2.3.3**), and then only when closely supervised by an experienced member of the team.

3.2.2. Education

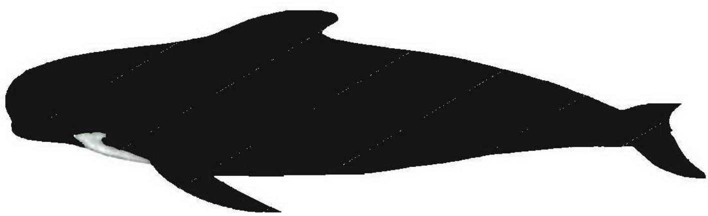
The Operations Center (*see* **2.3**) conducts educational programs to increase public awareness and appreciation of marine mammals and ocean health issues, encourage reporting of stranded animals, and promote involvement in network activities. Augment the program with lectures, posters, literature, public service announcements, press releases, and practice drills. Emphasize regional trends and patterns, such as mass strandings in the U.S. northeast and southeast, natural toxin poisonings along California or western Florida, or the arrival of pinniped pups ashore in the spring.

Most bystanders at a stranding will not have been exposed to the Operation Center's educational programs. Distributing brochures to persons on site can be a valuable recruitment tool. This literature should contain basic information on the regional stranding network, a fact sheet (Fig. 3.1) on the species that has stranded, a questionnaire for recruitment, guidelines on appropriate conduct and health and safety measures, and network contact numbers. It should also outline the range of actions possible with stranded animals, from immediate release to euthanasia.

When the stranding responder called to the beach finds a healthy pup in need of rest, placing a stake with signage stating that the animal has been examined and is being monitored will minimize redundant calls and spare the animal undue attention. As a way of informing the public, include the animal's common and scientific name, range, a few biological notes, and a word or two on stranding patterns.

MARINE MAMMAL STRANDING NETWORK FACT SHEET

Long-finned Pilot Whale
(*Globicephala melas*)



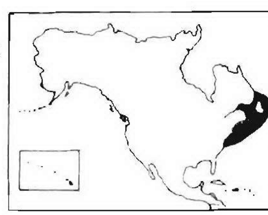
Range in North American waters: Canadian Maritime Provinces to Cape Hatteras.

Size: Adult males - max. 5.5-6 m (18-20 ft); adult females - max. 4.6-5 m (15-16.5 ft); neonates - 1.6-2 m (5-6.5 ft).

Distinguishing features: Body black with lighter anchor-shaped patch on throat; long (> 1/5 body length) sickle-shaped flippers; bulbous melon and indistinct beak; low, strongly curved dorsal fin placed well forward on the body.

Habits: Highly social, occurring in small to very large groups; generally pelagic, but moving inshore in late summer to late fall.

Stranding history: Occasionally mass strands throughout range.



REMINDERS!

The **Marine Mammal Protection Act** prohibits the handling of any marine mammal, dead or alive, and the taking of any parts (e.g., teeth, skulls) by unauthorized persons.

Stranding Network personnel are authorized to collect important biological data during marine mammal rescue and/or carcass salvage procedures and depend greatly upon the cooperation of the public.

Marine mammals may have **infectious diseases** potentially transmissible to humans and must, at all times, be treated with caution. Whales may thrash without warning, inflicting serious **injuries** to bystanders. Remain at a safe distance from any beached live animal, unless rendering assistance.

If you have any information about this stranding or wish to volunteer assistance, please report to a Stranding Network spokesperson. For further information on marine mammal strandings or on the work of the Marine Mammal Stranding Network in your area, contact:__________

Fig. 3.1. A sample fact sheet.

When possible, rely on a designated spokesperson, either staff or volunteer, to establish rapport with the public and report on progress and developments. Trained educators from schools, museums, zoos, and aquariums are ideal in this role and can also provide additional information on natural history, biology, conservation, and environmental concerns. A video display or a carcass moved within viewing distance of where public announcements are made can serve as an educational aid. While smaller networks may not have trained educators available, particularly for routine strandings, even small teams have people with good communication skills who can be designated as spokesperson.

3.3. CROWD MANAGEMENT

3.3.1. Establishing Boundaries

Large animals, mass strandings, or events on densely populated beaches often attract crowds that will require some attention to satisfy their curiosity. Observers may move in for a closer look if they are not kept informed and their questions go unanswered. The main objectives are to reduce disruptive noise and chaos, prevent accidents, avoid further stress and injury to the animals, and allow the team to proceed with their work.

Law enforcement officers are experienced in managing crowds; other officials, such as game wardens, marine patrol officers, and park rangers, also have the legal authority to do so. Town or regional officials will expect to be involved in any activities with potential impact on public health or property. The person designated for crowd management and the stranding coordinator can determine what measures need to be taken. However, while cordoning an area (e.g., with rope, barricade tape, or fencing) may deter entry, such symbolic barriers cannot be reinforced without legal authority. Generally speaking, the public has the right to be there, unless it is a private beach. Still, in the U.S., the Marine Mammal Protection Act protects animals from harassment, whether within their normal environment or stranded, and National Marine Fisheries Service (NMFS) guidelines for watching marine mammals include safe approach distances. Thus, **any actions that would constitute harassment or interfere with stranding response operations, including approaching too closely, are prohibited**. Most people will respect imposed limits if the reasons are clear; if necessary, involve local law enforcement officers. As a rule of thumb, establish ample boundaries for the team to work safely and effectively, with access to the ocean, and allow the public to move freely outside of that area.

Warn the public of the risks of approaching or handling a stranded animal, including physical injury and possible disease transmission (*see* Chap. 12). A balanced view will reassure bystanders that the chance of contracting an illness from a stranded animal is slight, but remind them that a carcass is no place for a picnic.

3.3.2. Explaining Your Actions

Clearly explain the intended procedures so that actions are properly interpreted. The approach to blood sampling, intravenous medications, and euthanasia all appear the same to anyone unaware of what is in the syringe. The use of a conspicuous tag to identify all carcasses will show bystanders that the response team has not left a live animal unattended or handled it roughly.

The stranding site is not the time or place for public debate. Beyond using the educational tools at your disposal, refrain from arguments over policies or procedures. Besides diverting energy from the work at hand, such discussions are likely to increase frustration for all parties involved.

Do not risk an animal's welfare for the benefit of science. Weigh the values when considering collecting biopsy specimens from live animals. (Note: in the U.S., collecting samples from live animals requires a separate research permit from NMFS[2]). Opening a beached carcass for samples while other animals await attention will evoke a justifiably irate response among observers.

Circumstances on the beach can change with a rising tide, advancing weather front, nightfall, or a team's dwindling enthusiasm and resources. Keep the public informed of any variation from the expected plan to avoid confusion.

The public and many team members may be unaccustomed to euthanasia procedures and respond with alarm if they are unprepared. While some are opposed to the practice, **most people accept the need to end pain and suffering humanely when no other options exist**. Still, advocates may find the practice upsetting. The designated spokesperson's responsibility is to explain in clear detail the need for this action (*see* **4.6**, **4.7**), how it will be performed, and possible complications. Be sympathetic to people's concerns and emotions. Warn observers that the procedure may be visually disturbing, and advise them that they or their children may not want to watch. Once the animal has been euthanized, consider the educational benefits of speaking to observers again, briefly answering any questions and, if circumstances permit, allowing them a closer look.

The visual and emotional impact of euthanasia will vary, depending on the animal and the method selected. When properly done, a lethal injection administered to pinnipeds and dolphins has a quiet and rapid outcome. The same procedure in a small whale may result in a brief period of unconsciousness (anesthesia) accompanied by tail-lobbing or thrashing. In the U.S., there is no preferred method for euthanizing large whales. Lancing and shooting require equipment that the public may find upsetting, and their use even more so (*see* **6.12**). (In the U.S., stranding network members may need prior consent from NMFS to use these methods.) Weigh the visual impact of the intended action and its effectiveness with the alternative of making the animal as comfortable as possible and allowing

it to die unassisted. If a visually disturbing method is selected, consider asking law enforcement officers to clear the area. This is essential when methods (e.g., shooting) pose any risks to human safety.

Careless remarks and inappropriate jokes reflect a callous attitude toward both the animals' distress and the team's effort. Squabbling over procedures and samples trivializes the importance of the operation and creates a poor impression. **Remember also that the media may be recording your every word and move.**

3.4. MEDIA RELATIONS

Strandings make excellent news items—the story of nearly mystical creatures trapped in a perilous setting. The event can grow from a local report to one of incredible proportions, as did the rescue of three gray whales in Alaska in 1988[1]. What began as a routine ice entrapment became an international mission to free the whales, driven largely by media reports.

Nearly everyone is influenced by the media. For some, it may be the sole source of information on marine mammals and stranding events. The more information we can provide, the more accurate the coverage will be and, in turn, the greater the value for public education and benefit to the stranding network. (A timely newspaper article can prevent the "rescue" of a healthy seal pup awaiting the imminent return of its mother.)

3.4.1. Organization

A media coordinator is essential for networks operating in areas where strandings generate large-scale public interest. One excellent source of candidates is the media relations department of a marine mammal display facility. While the media coordinator may not be on-site for every stranding, they should be available through the Operations Center. The general responsibilities of the position include:

- Working with the network to develop strategies for providing information to the public
- Educating staff and volunteers on appropriate interaction with media, and in some areas developing a communications team (in the U.S., NMFS offers opportunities for training)
- Providing the media with up-to-date materials, including press kits and statements
- Maintaining a phone list of key staff and press contacts
- Planning for consistent coverage of stranding events
- Coordinating and guiding media coverage at the stranding site, including regular press conferences and distribution of information packets, as appropriate.

Box 3.1. Suggestions for Media Relations[3,4]

A media coordinator is often not immediately available at a stranding event. Interested volunteers can be trained in basic media skills with the following guidelines:

- Remember that you represent an organization or agency: be polite and professional.
- If there are messages your organization is trying to convey to the public, incorporate them into the interview.
- Ask for the reporter's name, phone number, media outlet represented (station, channel, or newspaper), and when the story is expected to air or appear.
- Be concise, confident, and conversational. Speak in "soundbites."
- Speak to your audience and avoid jargon (e.g., industry terms, scientific names, etc.)
- Don't speculate or make up answers. If you don't know the answer, offer to find out, or refer them to someone who can respond accurately.
- Speak from your own experience. The media enjoy personal stories. If you are a volunteer, feel free to say you are and why you enjoy helping marine mammals.
- Refer the media to the stranding event's (or network's) media coordinator for follow-up.
- Inform the media coordinator about the contact, including the reporter's affiliation and contact number, what the interview was about, and when the story can be expected to run.

If your organization has a media relations team, work with them to establish strong working relationships with local newspaper and TV affiliates. This will facilitate communications during a stranding and generate helpful media support. Distribute a press kit to media representatives that includes a regional map, stranding patterns and brief descriptions of the animals typically involved, information about the network (from federal to local level), and a list acknowledging donors, contributors, and associated scientists.

Again, working through the media relations team, take the initiative to contact the press and keep them informed with information that is consistent and supportable. Maintain a good working relationship by avoiding unreasonable demands and being cooperative. If you offer newsworthy information first, the media may be more willing to print future press releases, including calls for volunteers and donations, and guidance for the public on what they should do if they encounter a stranded animal. Emphasize that reporters must clearly identify themselves and respect the need to minimize disturbance on the site (i.e., no helicopters).

3.4.2. At the Scene

The media coordinator (or designated spokesperson) is responsible for providing substantial, accurate information. Neither the team leader nor other members will have the time or information to assume this role and must defer questions when approached. At the stranding scene, press kits can be distributed from established communications stations to media representatives.

At large or controversial events, specify the times and locations of regular press briefings to be given by the designated spokesperson. If possible, include at least one of the investigating scientists on a predetermined schedule to satisfy the inevitable search for "better answers." **Conflicting views are unavoidable and can be presented to the media as a normal part of scientific inquiry.** Media representatives will appreciate the names and phone numbers of other experts in the field if they choose to pursue the story in more depth.

Politely ask the media to respect policies that will reduce stress on the animals. For example, ask them to stay a predetermined distance away from the animals, keep noise levels down, limit the use of flash, and avoid shining bright lights directly into the animals' eyes. Inform the media that animal care is the team's first priority and that a spokesperson will respond to their questions. Most reporters are working on deadline, so take the time to speak with them as soon as practical.

3.5. MAINTAINING PUBLIC AND MEDIA SUPPORT

Caution team members to respect the sensitivity of local residents. Unless you've had time to change out of your field attire or clean up, consider take-out food rather than a sit-down restaurant. Such courtesies will go a long way toward securing a base of support for future operations. Team members consumed by enthusiasm and fatigue easily forget that motel staff may be unaccustomed to dealing with cluttered rooms and messy guests, and that no one appreciates the sight of bloody boot prints while dining. Be considerate and responsible: minimize or repair damage to the beach as much as possible, and leave no trash behind.

A firm note of thanks will help keep the public and media trust and support, hard-earned throughout the event. Let them know the value of their participation and the outcome of the effort (*see* Chap. 14). Invite individuals to a public "stranding review" after major events to get input from the community, answer questions, and address any lingering issues. **Make a point of personally thanking the local community.** Be sure to send personal letters of thanks to town officials and key agencies and individuals. For large events involving many agencies and widespread support, consider placing a notice of thanks, with a list of supporters, in the local newspaper. Letters to the editor may be printed at no cost. Heartfelt thanks and free positive publicity for the town can promote lasting support.

Chapter 4
Decisions on the Beach

4.1. WHEN TO INTERVENE

Not every animal on the beach needs help. Pinnipeds normally require periods of time out of water, and even some cetaceans, which are virtually helpless on land, may occasionally cross the boundary between sea and land without undue risk. A beluga whale may come ashore to rub free a winter's accumulation of sloughing skin, a killer whale to snatch an unsuspecting seal, or a bottlenose dolphin after playfully riding a wave into the surf. Recognizing normal behaviors will avert any unnecessary action.

Certain conditions demand attention. A sea otter that is coated with oil, a fur seal too feeble to move, or a manatee with crippling propeller wounds is by any measure disabled and cannot recover without help. The same may be true for an animal in impending danger, for example, a subarctic hooded seal on a Florida beach or headed inland across a highway, or a harbor porpoise trapped in a fishing weir. Their peril is not as immediate as that of a dolphin on a hot beach, but they are nonetheless in difficulty and have a better chance of surviving if given some attention. "Nuisance animals" are a concern primarily in areas of dense human population: a California sea lion intent on following humans off the beach or determined to sleep on someone's front porch will bring a public demand for action.

In time, every rescue team faces an animal in circumstances that are ambiguous, in which the risk to health is debatable, and any action taken is certain to be questioned. What should be done for a lone young bottlenose dolphin lingering in a northern bay at the onset of winter, or a humpback whale that may (or may not) be too far upriver to find its way back, or the howling seal pup awaiting its mother's return from a foraging trip? Deciding what action to take in these situations requires an understanding of the animal's natural history, what typically happens when such animals are left alone, and intuition that comes only with experience (and mistakes).

The course of action may be determined by policy or logistics. In many cases, rehabilitation—particularly for cetaceans—is not an option, whether due to lack of facilities or resources, or regional or national policy[4,5]. The trend in Canada toward restricting release of rehabilitated marine mammals may, at some point, limit options for U.S. networks that now rehabilitate and release animals belonging to certain border-straddling stocks[4]. And while the practice is widely accepted for seriously debilitated animals, euthanasia is not always an option. The federal legislation in Mexico that prohibits anyone from injuring or killing marine mammals makes no exceptions for stranding networks, and penalties for infraction are severe. With limited options, public pressure to "do something" may force a team to attempt immediate release of animals that have little chance for survival[1]. On a more local level, an individual animal's fate may be overshadowed by priority considerations for endangered species, hesitation to add to the growing number of non-releasable animals, or concerns for introducing diseases into wild populations[4,7].

In making any decision, keep in mind that a rescue effort is notice to the public and authorities that the animal needs help, whether or not it really does. Aborting the plan because the seal pup suddenly woke up and dashed back to sea may be viewed by the public as a failed attempt, even if it is not. An effort to rescue a dolphin or manatee outside its normal range can escalate into a monumental, multi-organizational task that may ultimately cost hundreds of thousands of dollars. These uncertain situations, beyond all others, require sound evaluation and firm planning with the help of experienced colleagues.

4.2. WHAT ARE THE OPTIONS?

Once the decision is made to intervene, three options for immediate action are to return the animal to sea (either on-site or after relocation to a more favorable site), transport it to a care facility, or euthanize it. Another option is to take no action, other than to keep a conscious animal as comfortable as possible (an unconscious animal will feel no pain), and let the animal die a natural death. The decision is simple when dealing with a healthy wanderer that needs only to be returned to a suitable habitat or, at the other extreme, an animal that is clearly beyond help.

Most situations are more complex, and managing them must take into account, among other things, the likelihood of success and the safety of the operation. The "Decision Guide" (Fig 4.1) begins with the broadest question common to all situations—is enough help available? From there, a series of criteria will guide the approach one might use in most circumstances. When rehabilitation is not available, the decision on the beach can be even more difficult. As the options are weighed, remember the most important maxims:

- Protect human health and safety.
- Take no action that will only prolong the animal's suffering.
- Take no action that will jeopardize the health of wild populations (*see* **4.3.5**).

4.3. CRITERIA FOR MAKING DECISIONS

4.3.1. Logistic Support

A variety of options may be possible with adequate resources; little can be done without them. An experienced, organized, and well-equipped response team is essential. Involvement of volunteers with little or no training must necessarily be limited to non-hazardous activities. Good planning will ensure that the required level of support and expertise is available and will help to guarantee the success of the operation. Attempting too much with too little causes needless risk to both the workers and the animals. Dragging a pilot whale across a rocky beach for lack of a suitable carrier, or holding a seal in an unventilated box is harmful and unnecessary if help is only an hour away.

4.3.2. How Many Animals?

A small animal on an accessible beach usually requires simple straightforward action—few persons and little equipment—whereas a sperm whale or mass stranding is certain to stretch resources and demand an organized response. Most exacting are the large events of long duration, such as an extended die-off along a vast shoreline. In these circumstances, it will usually be necessary to conserve resources by being selective rather than attempt the type of exhaustive, uniform approach employed (at a cost of nearly 20 million dollars) to rescue and rehabilitate sea otters after the 1989 *Exxon Valdez* oil spill[2].

Attempting to give equal attention to more animals than resources allow assures inadequate care for any one. The action plan for a cohesive group of stranded pilot whales must take into account their social needs as well as physical health (*see* Chap. 7). A lone young survivor is not likely to prosper if it is released in an area devoid of other pilot whales and may be better placed in a permanent care facility or euthanized, difficult as that decision may be.

4.3.3. Environmental Conditions

The action plan must take into account the time of day, beach topography, sea state, and weather conditions. The terrain may be too rocky, muddy, or littered with sharp debris to move animals safely or use vehicles. Remote locations are naturally more difficult to manage. The characteristics of some beaches change seasonally (e.g., a harmless surf zone in the summer may develop a dangerous undertow in winter) and locally (e.g., a riptide caused by a nearby jetty). Harsh terrain, rough

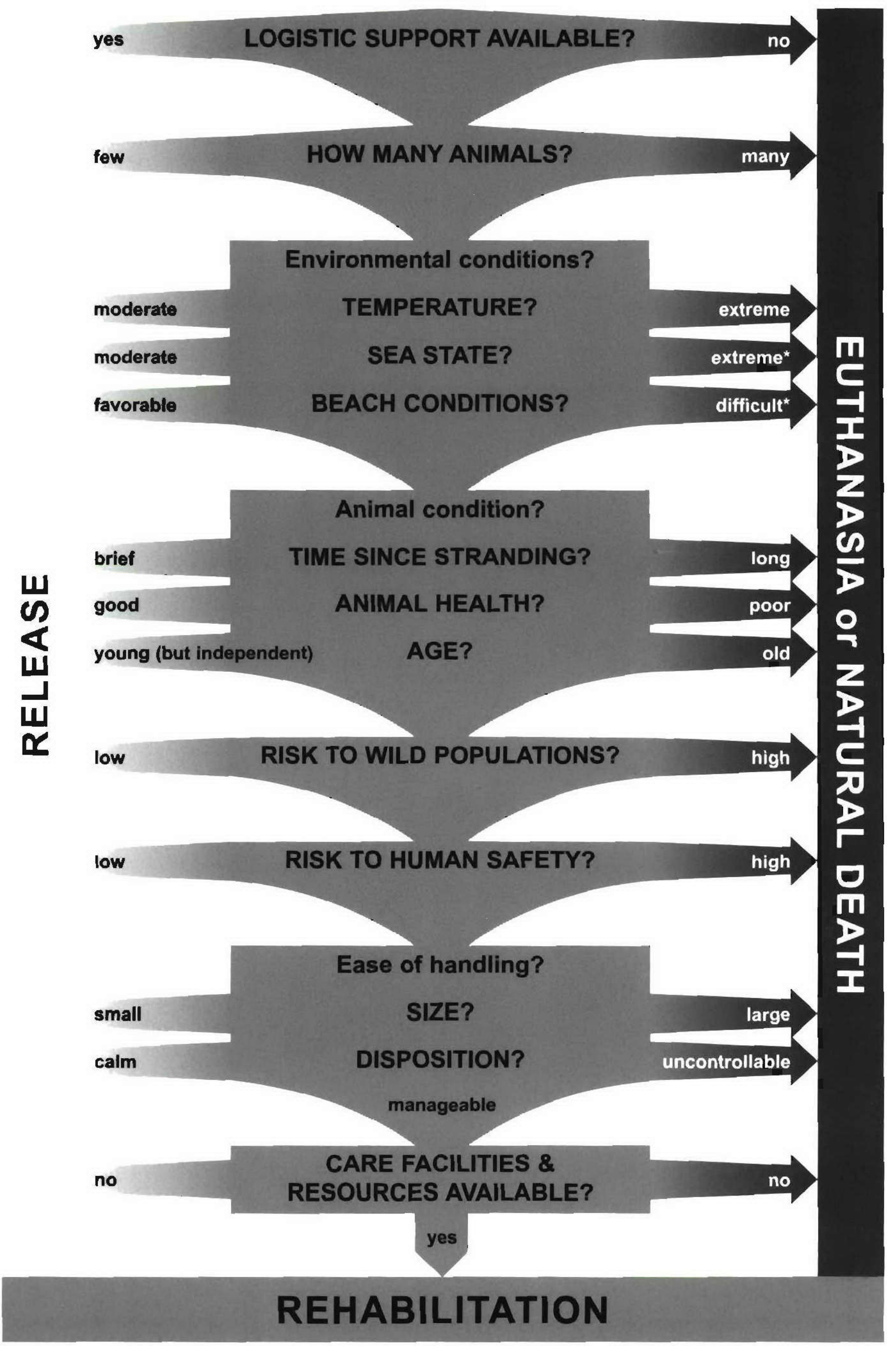


Fig. 4.1. Basic "Decision Guide" for live animals (* or wait for improved conditions).

seas, darkness, or simply a rising tide can increase the risk to animals and the team, and impede the rescue effort. **Consider human safety first.**

Severe weather may force a change in plans, or limit options. Rather than releasing an animal into the danger of a heavy surf, consider moving it to a safer site where first aid can be administered, observations continued, and decisions made under less pressing circumstances.

Cetaceans and pinnipeds are prone to **hyperthermia**. Their dark colors absorb heat, and blubber contains it. Circulatory adaptations for cooling are not efficient on land and break down completely with the onset of shock. For many reasons, the larger the animal, the greater the problem. Dehydration from warm winds and sunburn exacerbate the damage (*see* **5.6**, **6.6**)—particularly for cetaceans. A pinniped hauled out on a hot beach for a brief period may need no human assistance, whereas a stranded dolphin exposed to the same conditions requires immediate attention.

A manatee in cold water, a sea otter whose coat has lost its insulating properties, or cetaceans on a winter beach might be subject to **hypothermia**. This is less a problem with healthy pinnipeds and cetaceans, although prolonged exposure to near-freezing and sub-freezing temperatures may compromise even well insulated animals. Hypothermia is most common in animals with insufficient blubber—a characteristic of many of the seals and dolphins that come ashore. Small animals are more vulnerable to cold stress because their surface area is large compared to their mass. Extreme cold can cause frostbite and necrosis of the trailing edges of the flukes and fins of even robust whales, and may be hazardous to the response team, especially those working in the water (*see* **12.2.3**).

Wind exaggerates the effects of low temperature and hastens the onset of frostbite. Sand is irritating to the eyes and mouth and can be blown with enough force to etch glass, scour paint, and injure tissues of the animals and their attendants.

4.3.4. Animal Condition

A healthy animal is resilient, whereas one that is ailing may not survive the ordeal associated with the rescue. It is not always possible to distinguish between the two from their outward appearance; and from a distance, **it may be difficult to determine whether a whale is living, much less in good health.** Marine mammals seldom display expressions or postures suggestive of pain or discomfort, or abnormal behavior, unless seriously ill. The body contour of cetaceans and pinnipeds is formed largely by blubber, which retains its basic shape even when the animal has lost some weight. A decrease in blubber eventually leads to hypothermia, sooner in cold waters than in warm. Thus, a dolphin in northern latitudes dies before becoming emaciated, but in the tropics may linger to become very lean. In many cases, the health of an animal can be determined only after rigorous clinical examination.

For some species, the options are predetermined. Stranded sea otters and adult pinnipeds are generally too debilitated by injury or disease to be immediately returned to sea. Singly stranded odontocetes of social species are often ill as well, or may be separated from a vital group. The fate of these animals after release is uncertain; consider a care facility or euthanasia as options.

Larger, older animals generally decline in health more rapidly than smaller, younger ones. In pinnipeds, this is because most adults are disabled by injury and disease, whereas pups and juveniles come ashore often needing only food. Large size is detrimental to beached cetaceans because of the proportionally damaging effects of mass and gravity. Orphaned cetaceans have little chance of survival.

Prompt action can slow but not entirely arrest the deterioration of an animal's health on the beach[6]. Pilot whales released within 24 hours of coming ashore have restranded days later, still showing evidence of stress and shock caused by the first event[3] (*see* **6.6.2**). Little of this could have been gleaned from the physical appearance of the whales when they were pushed out. In such cases, blood chemistry might be more revealing, but the analyses may require more time or equipment (i.e., portable blood analyzers) than is available to the team. Before returning any animal to sea, consider that the process of recovery may take longer than environmental or logistic conditions permit.

4.3.5. Risk to Wild Populations or Human Safety

Marine mammals harbor a variety of bacteria, viruses, fungi, and parasites, some of which are transmissible to humans (*see* **12.2.2** and Box 12.1). Others, such as morbilliviral disease (e.g., canine, phocine, and cetacean distemper viruses), can be devastating to previously unexposed marine mammal populations (*see* **5.2**, **6.2**). Euthanasia of animals with suspected infection by virulent pathogens (i.e., showing clinical signs of disease or part of an infected group) may be a wise precaution if rehabilitation is unavailable—or if a willing facility lacks adequate quarantine space. Immediate release of stranded pinnipeds or sea otters that have been harassed or bitten by terrestrial carnivores such as coyotes, dogs, or foxes may risk introducing not only canine distemper virus but also rabies into the wild population, although reports of the latter are rare (*see* Box 12.1).

"Nuisance" animals might be released only to resume the behaviors that required their rescue (or capture) in the first place. Some may present unacceptable risks to public health and safety (e.g., young seal lions habituated to humans) or to other animals (e.g., a sea otter that drowns harbor seal pups during mating attempts). Options in these cases might include relocation, permanent care, or euthanasia.

4.3.6. Ease of Handling

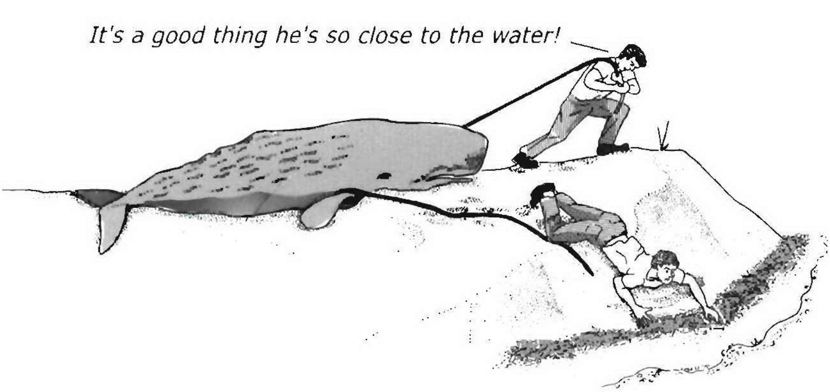
The ability to approach, handle, and move an animal depends on its size and demeanor. Some are small enough to be picked up by hand, have a calm disposition, and might even tolerate a car ride to the nearest facility, assuming a suitable cage is available. At the other extreme are animals that are too cumbersome to move without unacceptable risk. Little can be done for a large whale cast high and half buried on a silted beach during a spring tide, or for a vicious, old and injured walrus bull. Most circumstances lie somewhere in between. When in doubt, consider first the safety of the team and the best interest of the animal.

4.4. IMMEDIATE RELEASE AS AN OPTION

Return to sea is an option when:

- The animal is manageable and logistic support adequate.
- Beach and environmental conditions are favorable.
- The animal is healthy and able to function normally.
- The animal presents no apparent risks to wild populations or public safety.
- There is a reasonable chance that social requirements can be met (mother-young, social odontocetes).
- The area of release is within the natural range, suitable (out of harm's way), and navigable.

Singly stranded odontocetes, and sea otters or pinnipeds unable to leave the shore, are usually poor candidates for immediate release. Whether to release a large whale or smaller mass-stranded cetaceans will be determined almost entirely by the available logistic support. When dealing with the latter, attention should be given first to younger, weaned, independent animals; those in good health; and those on the beach for the shortest time (*see* **7.6**). Before returning animals to sea, a plan should be in place for visual or electronic monitoring (*see* **6.8.2**, **13.2**).



4.5. REHABILITATION AS AN OPTION

Rehabilitation is an option when:

- **There is reasonable chance that the animal can be restored to health and eventually released.**
- Adequate facilities are available and equipped for the species and number of animals involved.
- Arrangements can be made for safe and expeditious transport.
- The animal is manageable and poses no major risk to other animals or to facility staff.
- There are sufficient funds and staff to provide care for a reasonable period.

In the U.S. and many other countries, care facilities are increasing in number, capacity, and expertise for dealing with most pinnipeds and small cetaceans. There are only a few institutions large enough to accommodate a young gray whale or killer whale; most can only handle those up to the size of a pilot whale. Still, **the number of marine mammals coming ashore annually exceeds the capacity of existing facilities**. This pressure will increase as the growth of stranding networks and public interest continues to outpace the development of care facilities, thereby limiting rehabilitation as an option.

4.6. EUTHANASIA AS AN OPTION

Euthanasia is an option when:

- It is necessary to end suffering of an animal in irreversibly poor condition.
- The action is permitted by all relevant agencies.
- The decision can be made and the action directed by an experienced, qualified person.
- Essential materials and equipment are available.
- The procedure can be carried out humanely.
- No rehabilitation facility is available for orphaned dependent young.
- Rescue is impossible and/or no care facility is available.
- Animals persistently restrand.
- A distressed cetacean ashore is likely to attract others milling nearby to mass strand.
- Release endangers wild populations or public health.
- Carcasses of animals euthanized by toxic agents can be disposed of in a manner that minimizes risk to potential scavengers.

4.7. ISSUES SURROUNDING EUTHANASIA

Euthanasia of marine mammals is a contentious issue, much more so than the accepted practice of terminating the life of a pet or other domestic animal. Anyone facing this option should be prepared for opposition from both the public and other team members.

The U.S. Animal Welfare Act defines euthanasia as the humane destruction of an animal, using a method that produces near instantaneous unconsciousness and rapid death without evident pain or distress, or using anesthesia to produce painless loss of consciousness.

Intravenously administered anesthetic agents and euthanasia preparations that have been used successfully in pinnipeds and small cetaceans satisfy this definition; other approaches, particularly on large whales (e.g., suffocation, or firearms unless used by experts), may not (*see* **6.12** for a more detailed discussion).

In practice, public response influences the method of euthanasia, often for aesthetic rather than humane reasons. (Imagine the reaction to shooting a seal or draining a whale of its blood on a public beach.) These considerations aside, there is often philosophical opposition to euthanasia. Some find the practice unacceptable under any circumstance. Others, including team members, may be unwilling or unprepared to accept this action after having struggled earlier to save the animal's life.

At the stranding site, the topic of euthanasia must be broached with tact and consideration (*see* **3.3.2**). Members of the response team, the general public, and the media should be informed of the procedure in all its dimensions: the reasons, the approach, and possible complications. For smaller animals, such as pinniped pups and juveniles, the best approach may be to move the animal to a care facility or other location where euthanasia can be performed in a controlled setting away from public view.

The team carrying out the procedure must understand the potential complications that may occur in field situations and be prepared for contingencies. Consider, for example, that in cold climates, solutions used for euthanasia can freeze or become too viscous for easy use; that too little solution might be on hand for the number or size of animals involved; that finding a suitable vein may be difficult in an animal whose peripheral circulatory system has shut down due to shock or hypothermia; or that the animal may react violently, thwarting the attempt and placing team members at risk. A clumsy attempt to euthanize an animal without adequate equipment or expertise can cause more suffering than a natural death and promotes greater reluctance by the public and the team to accept euthanasia as a humane alternative. **Euthanasia must be carried out or supervised by experienced, qualified personnel with a detailed plan and adequate resources.**

Notes:

Chapter 5
Pinnipeds

5.1. BIOLOGY

5.1.1. Anatomy and Physiology[32,116,122,158]

The suborder Pinnipedia includes the sea lions and fur seals (family **Otariidae**), the walrus (**Odobenidae**), and the "true" or "hair" seals (**Phocidae**). Whether this diverse group arose from a single terrestrial ancestor or two separate lines is uncertain[72,161]. The latter view holds that otariids and the walrus descended from dog-bear stock and phocids from otter-like carnivores, with convergent evolution accounting for their shared characteristics. These include a streamlined body shape, limbs modified as flippers, simple teeth for catching fish, and adaptations for diving and thermoregulation. (*See* **15.1** for distinguishing features of each family.)

Certain obvious features distinguish phocids from otariids (Fig 5.1), most notably their contrasting methods of **locomotion**. Phocids move awkwardly on land. Unable to turn their hind flippers forward to support themselves, they hump along on their bellies, using their short foreflippers for an occasional boost ahead. They are more graceful in the water, propelling themselves by sculling with their hind flippers and using the foreflippers for steering. Otariids depend on paddle-like movements of their forelimbs for swimming, and on their hind flippers and a long neck for steering. Using both the fore- and hind flippers, they move on land with a speed and agility that allow them to utilize high rocky habitats inaccessible to phocids. The walrus uses the hind flippers for swimming, foreflippers for steering, and both sets of limbs for moving on land.

In fetal life, phocids develop a coat of woolly lanugo hair. Hooded seals, most harbor seals, and some bearded seals shed the lanugo *in utero*, while other species shed theirs a few days to several weeks after birth. While hair can provide up to 90% of the insulation for newborn phocids[87], it has little insulating value for adults;

they depend on a thick layer of blubber to retain body heat, as does the walrus. With less blubber than typical phocids, otariids are less tolerant of cold and rely on their pelage for additional insulation. Even with their dense fur, fur seals must remain active to prevent hypothermia when in cold water[45].

The **dentition** of most pinnipeds follows a rather simple scheme. Deciduous or milk teeth in phocids are resorbed before birth or shed shortly after, and those of otariids within 3 to 4 months. All teeth behind the incisors and canines have a nearly uniform shape characteristic for each species and are referred to simply as "post-canines." Growth layers in the dentine of canines, and cementum of post-canines, can be used to estimate the animal's age[74,85].

Pinniped **internal anatomy** is similar to that of most carnivores, with a simple stomach, small intestine, caecum, large intestine, and a multi-lobed liver. Some notable differences include the elongated thorax and obliquely oriented diaphragm, lungs made firm and "lumpy" by microscopic cartilaginous coils that surround the airways, lobulated kidneys, and a cardiovascular system specialized for diving (e.g., the immense hepatic sinus, an enlargement of the vena cava, acts as a reservoir of oxygenated blood during a dive). The testes in the Phocidae and the walrus are in the inguinal region, concealed between the blubber and the abdominal muscles. Otariids have a scrotum into which the adult testes descend during the mating season.

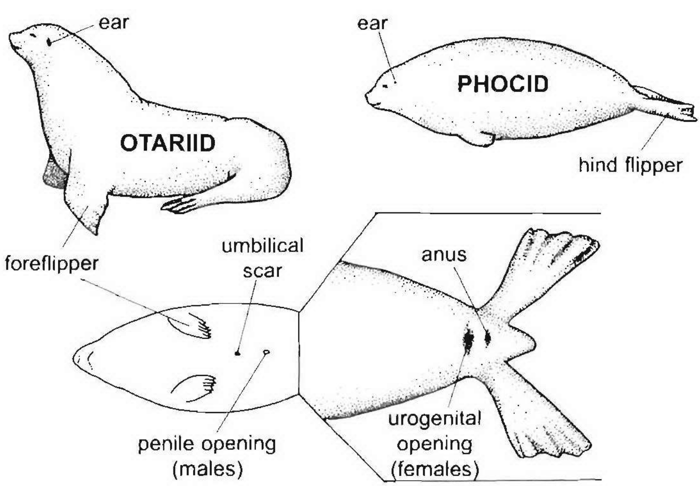


Fig. 5.1. External morphology of seals (Phocidae) and sea lions (Otariidae). The gender of a pinniped is easily determined. In the female, the anal and vaginal openings are close to each other, ventral to the base of the tail. The male has two widely separated openings, with that for the penis a few cm behind the umbilical scar. There is a well-developed baculum (penis bone). The distinction between young males and females usually requires close examination and manipulation. As the animals mature, secondary sexual characteristics become obvious. Males are usually larger and more robust and, in otariids, may develop sagittal crests and manes.

5.1.2. Natural History[11,15,85,122]

Females of most pinniped species become sexually mature by about 4 to 6 years of age, with some as early as 3 years (northern elephant seal) and the walrus as late as 6 to 9 years. Males reach sexual maturity at about the same age or slightly older but may not breed successfully until several years later. This is particularly true of highly gregarious species.

The 11- to 12-month **pregnancy period** includes a 2- to 4-month phase during which the newly fertilized egg develops into a blastula that remains dormant until the mother's hormonal levels allow development to proceed. By delaying implantation, the female can give birth during the same brief time each year when conditions are ideal for both mating and rearing pups. This synchrony is particularly important in polar environments. The walrus, which breeds every 2 or 3 years, has a pregnancy period of around 15 to 16 months, including 3 to 4 months of delayed implantation[33].

The **nursing period** of phocids is typically 2 to 6 weeks but has been compressed to an impressive 4 days in the hooded seal[14]. Females of most phocid species remain with their pups continuously until weaning; harbor, harp, and ringed seal mothers may leave to feed for brief intervals. Otariids provide maternal care for a few months to a year or more. During this time the female periodically makes lengthy foraging trips. Walrus pups may begin to feed upon bottom-dwelling invertebrates at 5 to 6 months of age but usually continue to suckle, at least as a dietary supplement, until about 2 years old[33]. **Knowing the maternal care patterns of pinnipeds in the region will help reduce the common mistake of picking up a healthy pup that is merely awaiting its mother's return.**

While generally favoring fish and squid, pinniped **diets** may include other invertebrates, seabirds, and for some, including walruses and Steller sea lions, other species of pinnipeds[13,44,98]. Most species, and certainly individuals, show preferences in their choice of prey, often determined by seasonal or regional abundance. Some pinnipeds, such as the harbor seal and California sea lion, feed in coastal waters and often enter rivers. Others, like the northern fur seal, northern elephant seal, and gray seal, forage in deep water, well offshore.

5.1.3. Distribution[85,122]

Pinniped demography is tied to a crucial need for land or ice on which to give birth and rear the young, social organization (solitary or gregarious), and feeding behavior[6,11,13]. Regional stranding patterns reflect these elements of life history. Orphaned pups of coastal harbor and elephant seals, as well as California sea lions, come ashore near rookeries with seasonal predictability, while adults strand in a scattered procession along their migration routes. Harp, hooded, and ribbon seals undoubtedly become orphaned and sick as well, but since they live far out

at sea, hauling out on ice rather than land, relatively fewer casualties reach shore. **Knowledge of animal distribution, habitat use, and normal stranding patterns is vital to recognizing unusual events.**

Pinnipeds are normally found along much of the North American coast north of the U.S. mid-Atlantic on the east coast and Guadalajara (Mexico) on the west. (*See* **15.1** for species information.) The **Atlantic coast** features only phocid seals and the walrus; the latter, once common as far south as Sable Island (Nova Scotia), is now restricted to waters from Labrador northward. Bearded and ringed seals occur year-round in the Arctic. Hooded and harp seals breed on springtime ice floes in the Gulf of St. Lawrence and east of Newfoundland. Gray and harbor seals range from Labrador to Cape Cod and even farther south. Before 1990, the harbor seal was the most common pinniped to strand along the U.S. Atlantic coast; the more pelagic gray seal trailed far behind, and hooded and harp seals stranded rarely[31]. This pattern changed significantly in the 1990s, with harp and hooded seals ranging southward in increasing numbers, perhaps due to changes in prey distribution or abundance in northern waters[99,107].

On the **Pacific coast**, the Guadalupe fur seal is found from the southern Gulf of California to California's Channel Islands, with the breeding population concentrated on Guadalupe Island, Mexico[1]. Largely pelagic, these fur seals rarely haul out on the mainland. The California sea lion, which accounts for the great majority of pinniped strandings in California[54], ranges from Mexico's Tres Marias Islands and the Gulf of California northward to Vancouver Island. They are found at sea, along the coast, and in estuaries and rivers; their primary breeding grounds are the Channel Islands, off central California. The Steller sea lion is found along more northern parts of the west coast, primarily in the Gulf of Alaska and the Aleutian Islands; breeding also occurs on California's Año Nuevo Island. The northern fur seal's range in North American waters is similar to that of the Steller sea lion, with principal rookeries in the Bering Sea (St. Paul and St. George islands) and another off southern California (San Miguel Island). Outside the breeding season, northern fur seals are largely pelagic and rarely found ashore.

The Pacific harbor seal ranges from Baja California to the Gulf of Alaska and the Aleutians, along the coast and in estuaries and rivers[2]. The northern elephant seal, the largest North American phocid, resides primarily along California and the Baja Peninsula but also migrates northward to British Columbia and the Gulf of Alaska during the warmer months, occasionally to the eastern Aleutian Islands, and rarely as far as Midway Island and Japan[141].

Farther north, the ringed seal is the most abundant phocid in **Alaska and the Canadian Arctic**. Rarely seen on land, these seals occupy shore-fast ice, where they can maintain breathing holes in surfaces more than 2 m thick[136]. Bearded seals

occupy a wide range of habitats over the continental shelf, preferring depths of 25 to 50 m[17]. The Pacific walrus is restricted to the Bering, Chukchi, and western Beaufort seas and breeds on offshore ice[33]. During summer months, adult males occupy traditional haulouts on land, mainly in Bristol Bay; females and young may haul out on land during fall migration and when ice is unavailable. Spotted seals pup and mate on pack ice in the spring and haul out on shore after the ice has retreated. The ribbon seal is virtually pelagic and rarely ventures near shore[17].

The only pinniped native to the **Hawaiian Islands** is the Hawaiian monk seal, which is largely restricted to the westernmost islands of the chain. This most tropical phocid faces extinction by every conceivable threat, including natural toxins, predation, entanglement in marine debris, and, for females and subadults of both sexes, death or injury from "mobbing"—attacks by groups of males intent on mating[5,50,88].

Pinniped populations in North American waters range from less than 1,400 Hawaiian monk seals[102] to an estimated 5.2 million harp seals[67].

5.2. MORTALITY

5.2.1. Natural Mortality

<u>Environmental Conditions, Trauma, and Predation</u>

As in other mammals, **mortality in pinnipeds is high in the very young, decreases rapidly with maturity, and increases again in advanced age**. Generally 10 to 20% of pups die before they are weaned, and 20 to 50% of newborns may not survive the first year. The leading cause of pup mortality is accidental separation or premature abandonment (e.g., due to the mother's inexperience, storms, crowding, trauma, illness, insufficient food, or human disturbance) followed by **starvation**[3,93,129].

Rookeries can be dangerous places for pups and adults when population density increases[3,64]. Young northern elephant seals[93], Hawaiian monk seals[50,159], Steller sea lions[129], and Pacific walruses[33] are bitten or trampled by adults, which are also victims of aggressive encounters. Injured animals may die of their wounds or through ensuing infection, starvation, or increased predation[3,84,124].

High mortality is often linked to **severe weather**. Storms and unusually high tides or persistent and extensive ice cover can destroy an entire season's pups[49,84,129]. The only known natural harp seal mass mortality followed a severe winter storm in the Gulf of St. Lawrence in 1973, when hundreds, perhaps thousands, of dependant pups and their mothers were crushed by broken ice[132]. El Niño-related storms result in unusually high pinniped mortality and strandings in some areas of the Eastern Pacific[146].

Reduced or altered **food supply** can affect the health of a population. Oceanographic anomalies causing drastic decline in prey species led to mass starvation of Galapagos fur seals and sea lions in 1982/83[145] and of Cape fur seals along southwestern Africa in 1993 and 1994[49]. The link is often less obvious. "Pinniped hyponatremia," a fatal disease induced by stress, was diagnosed in free-ranging ringed seals[47] at a time when persistent ice interfered with food production. Nutritional stress also has been implicated in gradual population decline (e.g., Steller sea lions in Alaska[147]) and high juvenile mortality (e.g., Hawaiian monk seals at French Frigate Shoals[53]).

Toxic algal blooms may be a growing threat, particularly to threatened or endangered populations. Both a dinoflagellate toxin and a morbillivirus were implicated in the 1997 die-off of Mediterranean monk seals at Cap Blanc, Mauritania, which claimed about 80% of the colony's adults[71,82,115]. More clear-cut is the role of natural toxins in pinniped mortality along central California. More than 400 California sea lions died or stranded in late spring of 1998, many after eating fish contaminated with domoic acid, a neurotoxin produced by the diatom *Pseudonitzschia* spp. The toxin was found in phytoplankton and anchovies, and in sea lion serum, urine, and feces[94,131]. This discovery clarified some previously unexplained sea lion strandings and die-offs in this region. Subsequent outbreaks have affected sea lions and other marine mammals from central California to Mexico[152]. Northern fur seals[84] and, in one instance, Hawaiian monk seals[52] have also died in circumstances suggestive of natural poisoning.

Predators take a toll on many species. Arctic foxes in some regions kill up to 40% of ringed seal pups hidden in their birth lairs[136]. Gulls and ravens also kill ringed seal pups, while polar bears and walruses prey on juveniles and adults[98,135]. Northern fur seal pups are eaten by Steller sea lions, killer whales, and sharks[44,84]. Sharks also prey upon harbor, harp, hooded, and gray seals in the Northwest Atlantic[2,16,99], Hawaiian monk seals[159], and northern elephant seals[141]. Transient killer whales prey upon harbor seals around southern Vancouver Island[2], while coyotes kill pups in some areas[140] (and may endanger rescuers, *see* **12.1**). Predator-inflicted injuries may bring pinnipeds ashore—and eventually into rehabilitation centers.

Parasites and Pathogens

Virtually all adults and most weaned pups serve as either intermediate or definitive hosts for many kinds of **parasites**[20,46,61] (*see* **10.12**). Mites occupy respiratory passages, and lice dwell on skin. Cestodes and nematodes are ubiquitous and include gastrointestinal roundworms, tapeworms, and hookworms, as well as heart and lung worms[104,106]. Protozoans include *Sarcocystis* sp., *Toxoplasma gondii*, *Giardia* sp., and *Cryptosporidium* sp.[24,89,105,112]. Except for hookworms in northern fur seal pups[84] and lungworms in California sea lions, northern elephant seals, and harbor seals[38,59], most parasites seem relatively harmless in an otherwise healthy

host. However, stress and pre-existing illness can turn innocuous parasites into serious pathogens that induce pneumonia, gastric ulcers, intestinal inflammation, encephalitis, and a range of other ailments seen in stranded animals[46,108]. Some parasites may even transmit bacterial or viral pathogens[41,95].

Bacteria rarely cause primary disease. However, as secondary invaders they can kill animals stressed by habitat degradation, malnutrition, parasites, and other debilitating conditions[5,26,30]. Infections complicate traumatic wounds[3,93], even the mild irritations that arise when a young pup drags its exposed umbilicus along a sandy beach[124,143]. **From a practical standpoint, secondary bacterial infections can mask or overwhelm the clinical picture of a stranded animal and therefore demand immediate attention.**

Leptospira interrogans (*see also* Box 12.1) is one of the few bacteria known to cause mass mortality in pinnipeds. Periodic autumn outbreaks of **leptospirosis** in California sea lions, caused by *L. interrogans* serovar *pomona*, are generally associated with severe renal disease in juvenile males and, less commonly, with abortion[23,51,57]. The same organism has caused neonatal mortality in northern fur seals in the Bering Sea[133]. A small outbreak involving *L. interrogans* serovar *grippotyphosa* in harbor seal pups in a California rehabilitation facility[139] suggests that other pinnipeds also may be susceptible to infection.

The role of other bacteria in die-offs—as primary pathogens or opportunistic invaders—may not be clear. In 1998, overwhelming infection with a perhaps previously unknown or difficult-to-identify bacterial agent may have killed more than 1,700 New Zealand sea lions in the Auckland Islands, although other predisposing factors were likely involved[26].

In the past decade, marine mammals have been struck with bacterial infections historically found in land mammals, including humans (*see* **12.2.2**). New strains of ***Mycobacteria*** **of the tuberculosis complex**, first diagnosed in captive otariids in Australia[34], are now known to cause disease in free-ranging fur seals and sea lions from Australia[19,160], New Zealand[77] and Argentina[7]. A recently discovered strain of marine ***Brucella*** is infecting many pinniped populations[81,101,110,121,148], as yet with no evidence of associated disease. (*See also* **6.2.1** and Box 12.1.)

Viruses were once considered insignificant factors in pinniped mortality. The 1955 die-off of crabeater seals (~2,500 dead) along the Antarctic Peninsula offered the first suggested diagnosis of a viral outbreak[92]. The demonstrated role of **avian influenza virus** in the deaths of at least 450 New England harbor seals in the winter of 1979/80[48] proved that viruses can be serious pathogens for some marine mammals. Since then, the **morbilliviruses**—a group that includes human measles virus and canine distemper virus (CDV)—have become the greatest viral threat

to pinniped populations[27,82] (*see also* **6.2.1**); two morbilliviruses—one previously unknown—have caused large-scale mortality. Phocine distemper virus (PDV), closely related to CDV, killed more than 18,000 harbor seals and a few hundred gray seals in the North Sea in 1988[68,114]; another outbreak, of similar scale and pattern, occurred in 2002[65,79]. CDV killed several thousand Baikal seals in 1987[56] and thousands of Caspian seals in 1997[35] and 2000[83]. Morbillivirus disease typically involves pneumonia, encephalitis, and immunosuppression, and death due to secondary infections[4,82].

We now know that morbillivirus infection occurs in many pinniped populations without causing widespread illness and was present in some long before the European outbreaks[27,82]. In the North Atlantic, harp seals are a likely reservoir for PDV and may have introduced the virus into immunologically naïve European seal populations[27,103]. Harbor seals may be particularly susceptible to PDV, and small outbreaks occur periodically along the New England coast[29]. Terrestrial carnivores are the likely source of CDV[27,82]. In the Southern Hemisphere, evidence of PDV and CDV infections has been reported in New Zealand sea lions and fur seals[28], and in Antarctic leopard and crabeater seals, respectively. Serological studies on the latter[9] tentatively link the 1955 die-off to CDV, perhaps transmitted from sled dogs.

Although as yet unreported in wild populations, **West Nile Virus** (WNV) killed at least four harbor seals housed in three different U.S. display facilities in 2002 and 2003; a few other seals showed evidence of infection[142,157]. These cases suggest that wild harbor seals, and perhaps other pinnipeds, might be susceptible to West Nile fever (*see also* Box 12.1).

Among other viruses found in pinnipeds[61,154], **herpesviruses** infect both Atlantic and Pacific phocids[55]. In European rehabilitation centers, phocid herpesvirus (PHV) infection in harbor seal pups has been linked to crowding, with death from pneumonia and liver disease[12]. In stranded harbor seal pups in California, PHV causes serious adrenal disease and, less commonly, encephalitis[60]. Another herpesvirus has been linked to the high rate of urogenital cancer in California sea lions[58,96]. **Calicivirus** (e.g., San Miguel sea lion virus) infection is widespread in North Pacific sea lions and fur seals[134,151]. Outbreaks of disease, characterized by blister-like lesions on the flippers, face, and mouth, are often seen in conjunction with other illnesses, such as leptospirosis[37]. Stranded gray seal pups in Britain in 1991 offered the first evidence of calicivirus infection in Atlantic marine mammals[138]. **Poxvirus** (parapox) skin lesions are common in stranded pinnipeds, particularly pups, and are readily transmitted in crowded conditions[73].

5.2.2. Human-Related Mortality

Intentional and Incidental Take, Entanglement, and Disturbance

Attitudes toward animals are partly shaped by social and regional values that span both ends of the ideological pole. For example, a seal just released from a recovery program may find itself in the cross-hairs of a gun sight if it invades a pen of farmed salmon. Despite legal protection in the U.S., some animals are shot because they are considered a nuisance, among them Steller sea lions[75], Pacific harbor seals[140], and California sea lions[54]. In Canada, aquaculture operators are licensed to shoot nuisance seals, and 500 or more harbor seals are shot legally each year in British Columbia[2]. Large numbers of pinnipeds are taken in native hunts—particularly phocids and walruses in the U.S. and Canadian Arctic[86,119], and in the Canadian commercial harp seal hunt, in which 250,000 or more may be killed annually[91].

For most species, the number killed deliberately is generally small compared to the thousands that are taken incidentally in **fisheries operations** or that become **entangled in marine debris**[97,118]. Northern fur seals and Hawaiian monk seals are particularly susceptible to entanglement in net fragments and packing bands and straps[36,70,88].

Other forms of human disturbance can be harmful, although more difficult to evaluate. For example, **human intrusion** on beaches was blamed for a rise in pre-weaning mortality of Hawaiian monk seals on Midway and Kure atolls in the 1950s and '60s[159]. Close approach by vessels and people, and low-flying aircraft have been reported to cause panic among harbor seals with resulting injuries and deaths[2].

Oil Spills and Other Contaminants

Oil spills were recognized as a cause of large-scale pinniped mortality in 1989, with the *Exxon Valdez* spill in Alaska (*see also* **9.2.2**). About 300 harbor seals died with degenerative lesions of the brain, probably resulting from inhaling fresh oil vapors[137]. These volatile fractions damage the lungs, enter the circulation, and attack the liver, nervous system, and blood-forming tissues[40,125]. Surface fouling by weathered petroleum residues, while less toxic, can irritate the eyes and mucous membranes, soil pelage and skin, and thus impair thermoregulation and interfere with locomotion. Pups relying on pelage for insulation are especially vulnerable. In 1997, about 3,200 South American fur seal pups died following a spill near their rookeries on Isla de Lobos, Uruguay[117]. In addition to fouled pelage, some pups probably ingested oil while nursing. After a spill in the Galapagos Islands in 2001, sea lion pups were observed with burns presumably caused by solar heating of oil on exposed skin[128].

There is growing evidence linking **other contaminants**, particularly organochlorines, with disease in certain pinniped populations. Some organochlorines may induce enzymes that lead to endocrine imbalances, with resulting effects

on physiology, development, and immune function[62,126]. A relationship has been shown between ingestion of contaminated fish and reproductive failure in harbor seals[120]. Other conditions circumstantially linked to organochlorines include abortion in California sea lions[21], reproductive tract abnormalities in European seals[69], bone lesions in Baltic gray seals[10], and skin disease in northern elephant seals[8]. Contaminant-induced adrenal gland disease has been suggested as a major factor in the decline in Baltic gray and ringed seal populations during the 1960s to 1980s[113]. Ongoing research on captive and free-ranging seals is generating data that supports the association between chronic exposure to certain contaminants and increased susceptibility to infectious disease[80,123,153].

5.3. STRANDING PATTERNS

With some exceptions, a stranded pinniped is likely to be a species that resides in the area permanently or seasonally, or that finds its way ashore at some point along its migratory route. In fact, stranding data are useful for mapping resident locations and movements of some species. For example, northern elephant seals and harbor seals in California faithfully reoccupy rookeries in winter and spring; some of their pups are certain to strand nearby. Armed with facts on the life history of a specific region's pinnipeds, one can reasonably predict the time and place that a given segment of the population is likely to strand.

Yet, there will always be unexpected appearances. With growing frequency, young hooded seals wander from their breeding sites in southern Canadian waters to New England, onward to the mid-Atlantic coast, and sometimes to Florida and the Caribbean[107]. If not a prank, it was a bizarre journey, probably across the Canadian Arctic[18], that brought a healthy young hooded seal ashore in southern California[25]. Harp and ringed seals also are appearing well south of their historical range. On the Pacific coast, Guadalupe fur seals are appearing farther north, possibly due to El Niño-related changes in environment or prey availability[63].

Following the general pattern of mortality, **first-year pups are the most likely to strand**. Most come ashore during the nursing period or soon after, particularly when that activity is interrupted by storms or other disturbances. Because their nursing period is brief, maternally-dependent phocid pups appear over the course of only a few days or weeks, whereas otariid pups rely on their mothers much longer and are more apt to suffer from any disruption of the mother-pup bond. The frequency of pup strandings tapers off after weaning, through a phase where individuals may appear with residual illnesses stemming from their early days on the rookery. Juveniles and adults come ashore for myriad reasons, with little predictable pattern, except for increased strandings that are associated with a fleeting incident such as a storm, or that signal the onset of an epidemic or toxic event.

5.4. STRANDING RESPONSE

5.4.1. Jurisdiction (*See also* 2.2)

In the **U.S.** and territorial waters, pinnipeds are protected by the Marine Mammal Protection Act of 1972. The Endangered Species Act (ESA) of 1973 applies to the Hawaiian monk seal, Guadalupe fur seal, and Steller sea lion. Work with ESA-listed species requires additional permits. Walruses are managed by the Fish and Wildlife Service (FWS), and all others by the National Marine Fisheries Service (NMFS). In **Canada**, pinnipeds are protected by the Fisheries Act and managed by Fisheries and Oceans Canada; the Atlantic walrus and Steller sea lion are protected under the Species at Risk Act. In **Mexico**, pinnipeds are included under federal regulations that forbid moving or collecting marine mammals without a permit. In these countries, stranding response activities, primarily rescue and release, are conducted under federal permit.

Procedures for reporting and handling stranded specimens tend to vary from region to region. In general, the Operations Center (*see* **2.3**) establishes a cooperative agreement with the responsible federal agency and carries out rescue, rehabilitation, and release programs with the agency's approval or direction. **Some countries or regions may restrict rehabilitation or release programs to reduce the risk of introducing diseases into vulnerable wildlife populations.**

5.4.2. Evaluating the Event

Pinnipeds haul out to rest, warm themselves, molt, mate, give birth, or nurse. Haul-out and rookery areas are generally well-known and long-established. Animals ashore in unusual areas might be resting, as is often the case with juvenile northern elephant seals. Pups of various species, particularly harbor seals, may be left on the beach while their mothers forage.

Assess pinnipeds from a distance (i.e., using binoculars) whenever possible to avoid frightening them into the water. Evaluate the reasons they normally haul out, and consider whether the place, time, and season are appropriate. Might the seal be fatigued during a long migration or after a storm? Is the pup abandoned or will its mother return? Is the animal in distress? Avoid actions that will disturb other marine mammals in the vicinity (e.g., a pinniped rookery). While deliberating, the only appropriate action is to protect the animal from disturbance and prevent approach by people or dogs. **Resist the urge to intervene until it is certain that action is required.**

More than one or two ailing pinnipeds on the beach simultaneously—particularly adults or subadults—might be the first sign of a toxic event or outbreak of infectious disease. Until a diagnosis is made, assume the latter and take steps to protect the team from unnecessary exposure to pathogens (*see* **12.2.2**).

5.5. CAPTURE AND HANDLING

A successful capture requires a well coordinated team. **Make every effort to capture the animal on the first try**; a seal that escapes may become wary and more difficult to catch. If additional attempts are necessary, use a different method, one to which the animal has not become conditioned. A prolonged capture will further debilitate the animal and may delay critical medical care.

The capture equipment and methods described below have been used successfully on a variety of pinnipeds. Established networks may have other preferred methods.

5.5.1. Specific Equipment (*see also* **2.5** and Box 2.1)

Much of the equipment required for pinniped strandings is geared to capture and transport (*see* Boxes 5.1, 5.2, 5.3). An animal larger than a harbor seal or young sea lion requires heavy equipment. (Refer to Fig. 5.2 for help in estimating an animal's weight.) Basic items for capture, handling, and transport include:

pole/hoop nets
throw nets
stretcher nets
rope
pole noose
cages (various sizes, with handles)
herding/"crowder" boards (3 minimum)
rescue vehicles (4-wheel drive, with bumper winch)
transport vehicle (enclosed, air-conditioned van)
heavy gauntlet welder's gloves
blankets or towels
water-sprayers/buckets
ice
poles to carry cages

Note: equipment for dead and sick animals should only be used for that purpose. **All equipment should be cleaned and sterilized after each use.**

5.5.2. Planning the Approach

Evaluate the animal's position in relation to the water. Threatened pinnipeds usually flee to the water, where they are difficult to catch (*see* Box 5.4). Rocks, vegetation, structures, and moored boats offer good cover for approach—as can the sea itself, provided conditions are safe for rescuers to swim in from either side, parallel to the beach. Approaches can also be made from small boats. Assess the feasibility of each strategy before moving in. It is wiser to wait for the animal to move to a better position than to attempt a rescue with little chance of success.

Once the plan is determined, brief the team. Emphasize safety. Take no action that puts the team at serious risk (e.g., rescue of pinnipeds on ice). Make sure everyone knows exactly where the animal is, what approach to take, and what to do. Remind team members to watch the leader for instructions. Work out hand signals in advance for use as the team closes in, and be prepared with an alternate plan.

5.5.3. Land Captures

Approach slowly and carefully. Even seemingly comatose pinnipeds may react with surprising energy. Pups often are less wary than juveniles or adults, and capture may require little equipment and only one or two people.

Keep a low profile; avoid standing in front of a contrasting background. Crawling helps but limits the ability to act quickly. Use available cover, including herding boards, to best advantage. If the animal sees you, freeze until it relaxes its vigilance. **Avoid loud noises.** For example, use hand signals as the team gets closer.

Box 5.1. Equipment for Land Captures (*courtesy of* P. Howorth[76])

Hoop (or dip) nets: Best for land captures (Fig. 5.3). Circular hoop (<1 m diameter) with long aluminum or stainless steel handle covered with split rubber hose. Or **1)** using 1-inch, schedule 80 PVC plastic pipe, heat center 3 m of 6-m-long pipe to form a hoop with straight double handles. **2)** Seal ends so it will float. **3)** Thread 3-m-width, 1.5- to 3-m-deep, nylon or other synthetic net around hoop (twine breaking strength of ≥50 kg and stretched mesh size ~5 cm square). **4)** Sew edges together. **5)** Sew bottom or use drawstring to allow release (a slipknot will hold and allow quick release). This device will be strong enough to capture large pinnipeds (>500 kg). **Note:** Smaller mesh nets are heavier and more cumbersome when wet or sandy.

Breakaway hoop nets: Useful for large animals. Made as above, but net is taped or otherwise secured on hoop so it will break free. Net is closed by a drawstring, which can be held by rescuers or attached to a solid object.

Pole noose: A pole with a noose at the end, which is slipped over the animal's neck, then drawn tight (Fig. 5.3). Impractical for lively animals but useful in tight spots. Once caught, secure the animal (e.g., with hoop net) and **release the snare quickly** to avoid choking. **Caution: places rescuers at greater risk of bite injuries.**

Herding boards: Plywood boards with handles in the back (Fig. 5.3). Useful to conceal approach during rescue (drill small peepholes along the top quarter of the board) and to coax and maneuver animals into cages. Useful also as ramps, levers to get animals into carriers, walkways over mudflats, tailgate extensions, etc.

Throw nets: For large phocids (otariids are too agile) (Fig. 5.4). Nets are thrown over the animal; some have drawstrings to secure the animal within the net. Size depends on size of animal to be captured.

Stretcher net: A stretcher made of netting instead of fabric (Fig. 5.4). **Caution: offers minimal protection from bites.**

Net gun: Uses blank rifle charges to hurl 4 projectiles, each attached to a corner of a square net, out of 4 barrels. Effective up to ~30 m in calm conditions. (**Note:** Spectra™ nets are stronger and fly faster and farther than nylon.) Used for unapproachable animals and those near the water. Once net is fired, secure animal quickly (e.g., with a hoop net). Attach thin nylon line with foam buoy (to clip under net canister) to allow retrieval of net (and sometimes the animal) from the water. **Caution: the projectiles are dangerous.** Make sure no people or other animals are near the target, and use only in areas free of obstructions. **Restrict use to persons skilled with firearms.** Training and practice are essential.

If cover is sufficient, approach from either side, so that rescuers arrive simultaneously and block escape. When possible, approach from the seaward side to prevent retreat into the water. Use personnel strategically (e.g., to frighten an animal toward hidden rescuers or to intercept a fleeing animal). Ideally, have back-up personnel ready in case the animal eludes the first team member's capture attempt.

Hoop or dip nets are preferred for most beach rescues of otariids. The hoop is dropped over or in front of the animal, then slammed down to prevent escape. The hoop is then forcefully pulled away (causing the animal to slide deep into the net), and raised and rapidly twisted, securing the animal in the net (Fig. 5.3). Other rescuers then assist with additional nets.

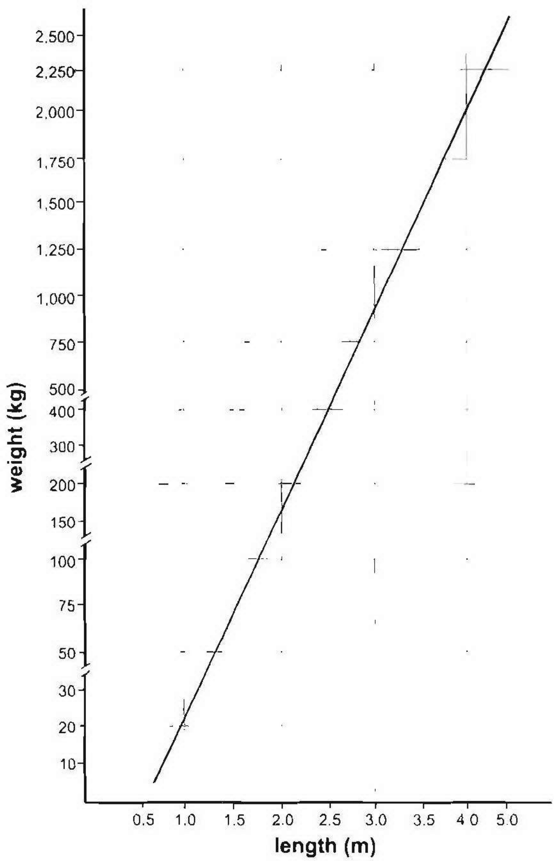


Fig. 5.2. This graph can be used to estimate the weight of a pinniped of any given length. Derived from sources used to prepare **15.1**, it is based on average to maximum size and represents species occurring in North American waters. **NOTE: Do not use this as a guide for administering medications or anesthetics**: many stranded animals are emaciated and fall far below this average range, while others (e.g., pregnant females and well-nourished pups) may be above it.

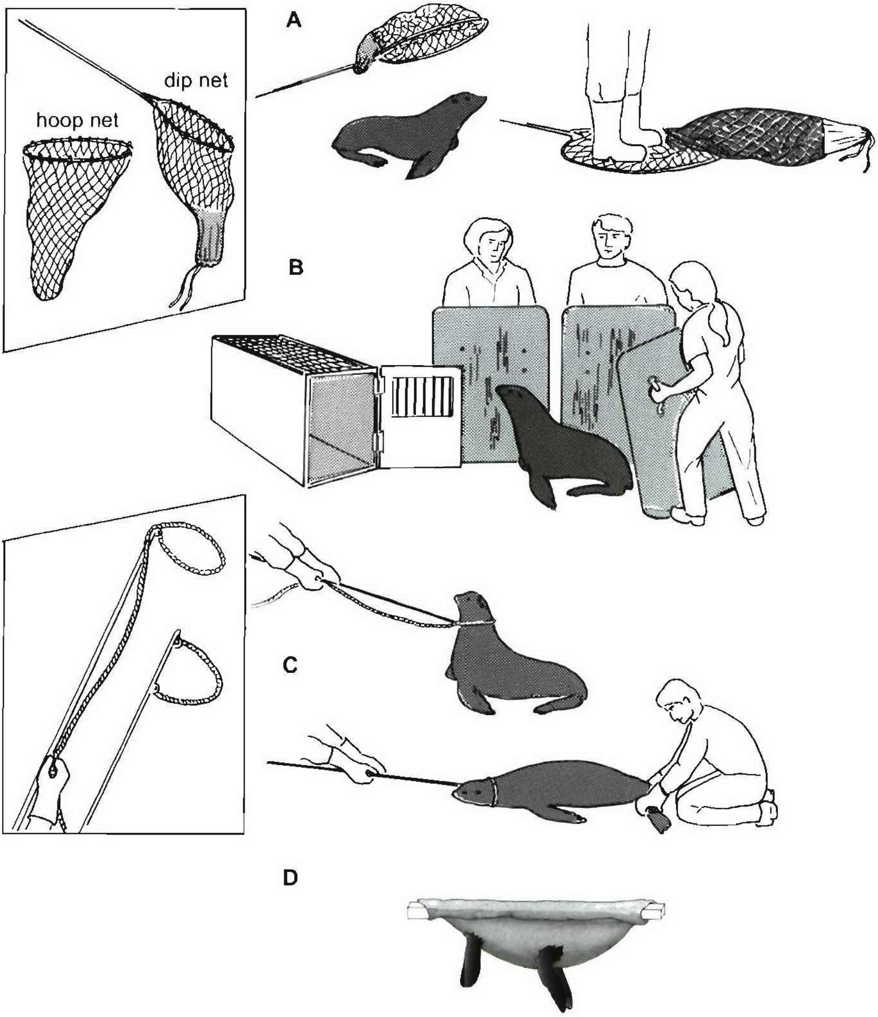


Fig. 5.3. Capture and handling otariids and large phocids. **A.** Capture of small otariids with hoop or dip nets (inset). **B.** Use of herding boards to maneuver animal into cage. **C.** Capture with pole noose (inset) and restraint of hind flippers[43]. **D.** Restraint method for otariid pups (redrawn from Gentry and Casanas 1997)[42].

A **net gun** is useful when a pinniped cannot be approached without frightening it into the water. (Be sure to have all necessary permits and notify local authorities of your intentions.) Once the gun is fired, all team members should immediately converge on the animal with hoop nets. Animals deep in rocky crevices can be snared with a **pole noose**[43], then pulled into the open and netted (*see* Box 5.1).

Once secured in a hoop or dip net, flipping the animal back into the hoop allows the hoop to be used as a stretcher for moving the animal to a secure location. If necessary, the net can be tied securely shut, and the animal swum out to a boat or floated to a more convenient location.

To transfer an animal from the net into a cage, unwind the net, place the hoop around the cage opening, and pull the net forward. Herding boards or additional nets can be used for pushing from the sides and behind. Have other team members ready with nets in case the animal breaks free. Alternatively, using a net that is loosely tied at one end allows rescuers to pull the netted animal into the carrier, and then release the animal from the net. The cage can then be put into a vehicle or wagon for transport. Rope loops added to cages can be used as handles or to support poles for carrying. A small plastic sheet (e.g., as sold for snow sledding) can be used to help slide wooden cages along sandy beaches.

Box 5.2. Equipment for Water Captures (*courtesy of* P. Howorth[76])

Large nets or Modified gill nets: Usually less than 100 m long and 5-6 m deep (twine breaking strength ≥50 kg, mesh ~10 cm square). Suspend vertically in water with floats on surface and lead line weighted to barely sink the bottom edge, allowing trapped animals to easily surface to breathe. Can be folded into box with ends pushed through openings to allow easy location of net ends for deployment. To avoid tangling, tie lead line to float line at 3-m intervals (unfasten after deployment). Can be anchored at each end or used like a purse seine between two boats (*see* Box 5.4). Can be used in conjunction with a slatted wooden cage (*see* Box 5.3) and poles with blunt-tipped hooks for removing net as animal is pulled into the cage. **Caution:** entrapped animals can drown. **Monitor continually while in use.**

Floating or Water nets: For rescuing animals hauled out on docks, boat slips, rocks, and buoys. Consists of rectangular frame of 1-inch, schedule 80 PVC pipe (1.5 x 2.5 m maximum size for easy handling, and sealed so it will float) with a net (strength and mesh size as above, ~2 m deep) that is closed and weighted at the bottom (Fig. 5.5). The net is gathered and tied to the frame, then released when almost in position. Long, removable handles allow net to be maneuvered (from water or land) under the animal without frightening it. To prevent escape, raise device out of the water as soon as the animal jumps in.

Platform traps: For capturing problem animals that frequent certain locations. Consists of low-floating platform that is moored in place and rigged with either a "shotgun" net that flies over the animal, or a chain link enclosure that can be closed remotely. Trap is sprung when the animal hauls out.

Phocid pups may require considerably less logistics but can be deceptively heavy and difficult to grasp by hand. Young seals often can be secured with a **stretcher net or throw net**, a blanket, or even items of clothing for placement into a transport carrier (Fig. 5.4). Boxes can be designed specifically for capture by incorporating an opening at each end with drop-in doors that will encourage the animal to enter, believing it has an escape route at the other end. A seal can also be herded into a box that can then be turned upright and covered with a lid. If necessary, a small seal can be chased into a clean plastic trash can, using the lid for herding (or as a visual barrier) and the handles for carrying it over rough terrain.

5.5.4. Handling and Restraint

Handling pinnipeds requires skill and common sense. Even when wrapped tightly in nets, they can still bite. Be careful at all times. Wear heavy clothing, boots, and gloves. Treat bite wounds immediately to prevent infection (*see* **12.2.2**).

Phocids can be managed with stretcher nets, throw nets, and hoop nets (Fig. 5.4). Thereafter, a smaller animal can be restrained by one or two people straddling it, immobilizing the animal's shoulders with the restrainer's knees and securing the head with both gloved hands placed firmly behind the head. Use as little force as necessary, and do not sit or place your full weight on any seal. A small seal can suffocate under the weight of a handler, especially if rocks or sticks are pressing

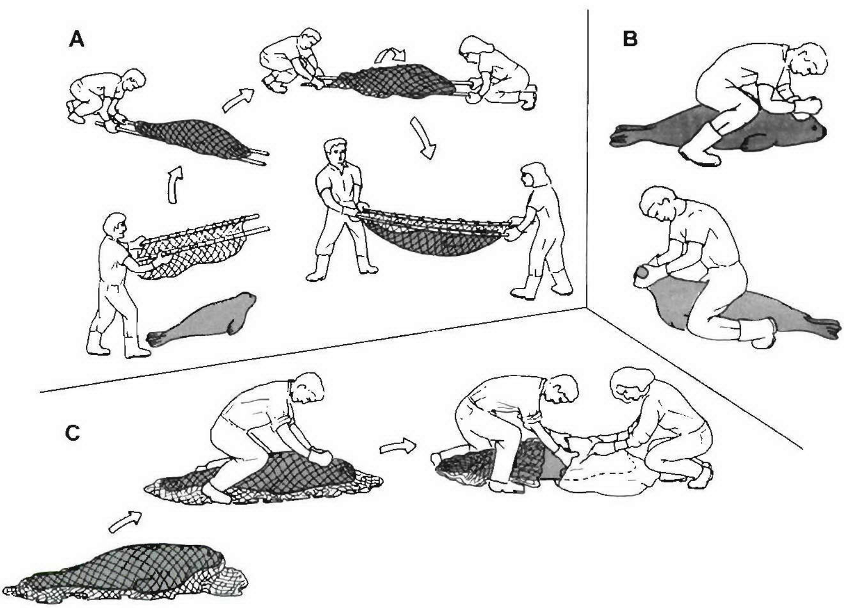


Fig. 5.4. Capture and handling phocid seals. **A.** Use of net stretcher in capture. **B.** Physical restraint suitable for small phocids. **C.** Capture and restraint involving throw net, physical restraint, and covering head.

Box 5.3. Cages and Accessories (*courtesy of* P. Howorth[76])

Plastic kennel cages: Used for shipping dogs and other animals; readily available; easy to clean and store. They come with metal fastenings, but plastic cable ties allow fast assembly. Carriers can be modified with U-bolts and rope handles to ease carrying and a "quick-release" door. Make a false floor using PVC grid to allow wastes to pass through to the bottom. **Note:** plywood is difficult to sterilize; avoid use for surfaces upon which animals may urinate or defecate.

Slatted wooden cages: Have sliding guillotine door and slatted back, sides, and top (Fig. 5.5). Can be used in conjunction with modified gill nets, placing the cage in the water behind the trapped animal. A quick-release lasso (i.e., simple hitch knot), secured around the hind flippers, is used to draw the animal into the cage as the net is removed. Buoyed by attached floats or other means, the cage can be used to move the animal to a boat or to another location; make sure the animal's head is above water during transit.

Squeeze cage: Used to restrain animals for examination, tagging, etc. The tubular metal cage is made in a wishbone shape and the tubes are covered with rubber hose. The slatted wooden cage can also be used as a squeeze cage by installing a hinged plywood floor that can be raised with four lines, pinning the animal against the top.

Wagons: Used for moving cages along beaches in areas difficult to reach by vehicle; use wide wheels. (Roleez® makes heavy-duty inflatable wheels that work well on sand and rough terrain, and a jet-ski dolly that makes a good cart for animal carriers[162].)

into the thorax. One strategy for moving a large passive phocid (up to 135 kg) is to roll it in a blanket and onto a stretcher for removal to the transport vehicle, where it is transferred to a cage and the blanket removed immediately. Draping the head with opaque cloth sometimes has a calming effect.

Small otariids can be handled like phocids. Another method for restraining otariid pups[42] uses a fabric square (1 m x 1 m) with one side fixed to a pole or beam and four holes through which the flippers are inserted; with the pup in place, the two sides of the fabric are rolled together over the pole until the pup is secured (Fig. 5.3). This method allows simple procedures to be carried out. Larger pinnipeds are best restrained for handling using squeeze cages or other specially designed devices.

Restraint beyond these simple measures may require chemical immobilization[39,66,100], which is always risky. Apart from the usual problems encountered when sedating or anesthetizing pinnipeds are the added complications of accurately judging the weight, the blubber thickness that the needle must penetrate, and the health of the subject. **Chemical immobilization must be carried out only by qualified individuals.**

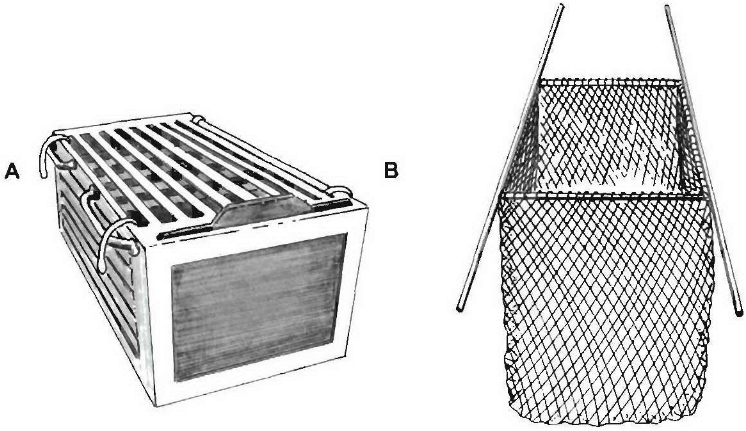


Fig. 5.5. Equipment for water captures. **A.** A slatted wooden cage with a sliding guillotine door and a slatted back, sides, and top can be used to secure a pinniped removed from a modified gill net (*see* Box 5.3). Buoyed by attached floats or other means, the cage can be used to move animals by water to a boat or to a site with better vehicle access. **B.** A floating net used to capture pinnipeds hauled out on docks, buoys, etc., as described in Box 5.4. **Note:** dip nets (Fig. 5.3) are also widely used for capturing pinnipeds in the water.

5.6. FIRST AID

An animal's health can be roughly determined by its physical appearance and behavior. Animals that are unresponsive, emaciated or severely injured, or that shows signs of weakness, blindness, paralysis, or rapid or open-mouth breathing (normal breathing rate is 3 to 6 breaths/minute) clearly need help. Those in obviously critical condition may be candidates for euthanasia (*see* **5.11**).

If rehabilitation is appropriate, prepare the animals for transport and remove them from the beach as quickly as possible. Little can be done on site to relieve a pinniped from the probable condition that brought it ashore, except cutting away netting or other debris (*see* **13.1.2**), which may be better effected by trained personnel in the controlled setting of a rehabilitation center. Even treating lacerations requires procedures that are better carried out in a care facility.

While awaiting transport, keep the animal cool (with water or ice) and sheltered from warm temperatures, direct sun, and blowing sand. Signs of overheating, or **hyperthermia**, include warm flippers, flipper waving, panting or open-mouth breathing, and, in some severe cases, seizures. In freezing weather, a thin animal may require protection against **hypothermia**. Use a blanket to cover a scrawny pup that is shivering or has cold flippers, but be sure to monitor to prevent overheating once it is warm. Also, remember that pinnipeds may chew and choke on blankets and towels, which can also become a source of infection if contaminated by

Box 5.4. Water Captures (*courtesy of* P. Howorth[76])

Caution: water captures require personnel skilled in small boat operation, net handling, swimming, and diving. Always wear safety flotation vests when working in or near water. Guard against hypothermia. Never work alone.

Open ocean: A **large net** (Box 5.2) can be pulled out of its box on the deck of one boat by another boat. As the net emerges, the lead line stretches the net vertically in the water. Once deployed, the ends are secured to each boat's stern. One boat then slowly turns, coming onto a parallel course with the other. Once the net forms a large "U", both boats move slowly toward the animal, closing the net by bringing the boats together. Alternatively, a third boat can be used to herd the animal into the net. Once caught, the animal can either be pulled carefully aboard with the net, or removed while the net is in the water. This method is most effective when underwater visibility is poor (i.e., the net is difficult for the animal to see).

Coves, beaches, etc.: Beaches, coves, and parts of rivers or streams can be partly or completely closed using a **large net** stretched across the area, with the ends anchored or tied to shore. Leaving the lead line tied to the float line makes deployment easier. If the animal comes and goes from the cove, the net can be left secured and then quickly unfastened when the animal is hauled out. Entrapped animals can be removed while the net is in the water or by pulling the net ashore. Alternatively, deploy a large net as described above, then attempt capture using **hoop nets and/or a net gun**, either from land or sea. The large net in the water serves as a backup if these attempts fail.

Rocks, buoys, boat slips, etc.: Floating nets (Fig. 5.5) are useful for capturing pinnipeds hauled out adjacent to relatively deep water. The device can be deployed by a swimmer or can be pushed along from a dock (using a slightly bent handle so it can be pushed from above). Place the net where the animal is most likely to jump into the water, and move other team members into place. If frightened, the animal will likely jump into the net; if not, attempt capture with hoop nets. If this fails, the animal will almost certainly jump into the floating net. If possible, have personnel standing by in a small boat, ready to move in and lift the frame from the water as soon as the animal jumps into the net. Hoop nets should then be dropped over the frame to prevent escape.

feces or body fluids. Pet stores sell a heavy plastic disk that can be heated in a microwave: a slightly heated disk can be an effective way to warm an animal[162]. If any warming method is used, make sure the animal can escape the heat source.

When treating pinnipeds fouled by **oil**[40,156], the best approach is to clean and release otherwise healthy seals on site, rather than subject them to the stress of transport and rehabilitation, provided there is little risk of additional exposure. Contingency plans and ready access to resources are critical for setting up the pens, cleaning facilities, and field laboratories necessary to effectively manage large-scale events. See, for example, the protocols for oiled mammals issued by the California Oiled Wildlife Care Network[111].

5.7. IMMEDIATE RELEASE

Candidates for immediate release include healthy seals that may have strayed too far inland or have come ashore entangled, as well as lightly oiled juveniles and adults that can be released into a clean area. Ordinarily, any seal that is stranded due to injury or illness is fit for release only after rehabilitation.

Releasing a pinniped generally involves little more than opening a cage door at a suitable shoreline site. Find a remote beach near haul-out sites occupied by others of the same species. Let the animal enter the water of its own accord; it will probably swim away before long. Pinnipeds need no help orienting themselves; **it is unnecessary—and dangerous—to enter the water with the animal**.

All pinnipeds should be tagged before release (*see* **5.10.2** and **13.2**). Record the location and time of release, along with other life history data and tagging information, as part of the animal's permanent record.

5.8. TRANSPORT TO CARE FACILITY

Transport cages must be large enough for an animal to stretch out, raise its head, and turn around. Some more aggressive species, such as hooded seals, are better off in smaller quarters. The cage must permit free air circulation and prevent contact with wastes, yet have openings small enough to discourage the animal from biting the caging material (or anyone near it) and damaging its mouth. Make sure the cage door is secure to prevent escape; never underestimate a seal's ability to outwit its rescuer! Lightweight materials make large cages easier to lift.

When transporting by road, protect animals from exhaust fumes, direct sun, heat, wind, and freezing temperatures. Aim for a temperature of 10° to 20°C. Secure the cages to minimize shifting, and include equipment needed for transfer of animals by hand, forklift, or crane. When possible, select a truck with air shock absorbers ("air-ride suspension") and a hydraulically operated rear platform. Small pups can be carried in the back seat of a car, though not all family members will appreciate the lingering evidence. A small plastic kennel cage is ideal for transporting pups.

Pinnipeds in transit can overheat. Monitor closely for signs of hyperthermia. Stereotypic behavior, such as pacing, will compound the problem. Plan the transport so animals are not left unattended for more than 2 to 4 hours at a time. When you can, refresh the animal by wetting it with water; some may even drink water or chew on ice. In colder climates, keep arctic phocid pups dry, but allow access to fresh, cold air. Some snow may be provided, but watch for signs of hypothermia resulting from melt-water. Avoid commotion and unnecessary attention.

5.9. REHABILITATION

5.9.1. General Considerations

Few satellite facilities (*see* 2.3.1), and no beach residents, have the resources to rehabilitate a stranded pinniped. They can, however, while arranging for transport to a rehabilitation center, shelter it from the elements, isolate it from domestic animals, and provide fresh water for cooling and drinking.

The physical and organizational needs of a large-scale rehabilitation center are substantial. More than a collection of cages, pools, and haul-out decks, it must provide for emergency treatment, nutrition, surgery, quarantine, chronic care, and raising orphaned pups. Some operations continue around the clock. It also serves as a halfway house for seals prior to release, and as a laboratory where information is gathered on ways to improve standards of care. Pinnipeds should not be rehabilitated in "mixed-species" facilities, where diseases from terrestrial animals could be acquired and transmitted to wild marine populations after release. U.S. Animal Welfare Act regulations for marine mammal housing and care[149] do not (yet) govern rehabilitation centers. However, these guidelines provide reasonable minimum standards, especially for animals needing long-term rehabilitation.

At the rehabilitation center, strandlings should be weighed and given a visual examination. Detailed clinical evaluation, including blood studies and parasitological and microbiological screening[22,38], can wait a day or so, until the animal has had a chance to recover from the stress of capture and transport. Even then, diagnostic indices such as respiratory and heart rates and body temperature may be misleading. As an example, some phocids become "cataleptic" and momentarily stop breathing when restrained. Be cautious when examining the mouth of an uncooperative animal, and never force the eyelids open for close examination; eyes have been punctured in such attempts.

New arrivals are usually malnourished and nearly always dehydrated. The first steps are to restore fluid and electrolyte balance[155] and treat for hypo- or hyperthermia, injuries, and infections. When dealing with contagious pathogens, protect animal handlers and other strandlings particularly susceptible to infection. **Take necessary measures to reduce the spread of disease between animals within the rehabilitation center as well as from outside sources.** Heavily oiled pinnipeds must first be stabilized to ensure they are strong enough to withstand the rigors of cleaning[40,156].

In cases of long-term rehabilitation, use environmental enrichment to stimulate natural behaviors. Operant conditioning may help reduce stress during medical and husbandry procedures (counter-conditioning will be necessary to prepare the animal for release)[130].

5.9.2. Nutrition

Strandlings generally fall into two dietary categories: premature, orphaned, and recently weaned pups that need specially prepared formulas[144], and subadults and adults that do well on whole fish. A phocid pup in good condition can be given several feedings of 100 to 200 mL each of electrolytes or water during the first 24 hours, then the same quantity of special formula—gradually changing from dilute to full—over the next 2 days. The pup is then weaned onto fish in about 4 to 5 weeks. Weigh pups periodically, at the same time of day. Aim for a target weight, usually taken as the weight at weaning of a free-ranging pup of that species (*see* **15.1**).

Otariids normally nurse for much longer, up to 6 to 12 months of age. However, hand-reared pups can be weaned within a few weeks or months on formulas similar to those used for phocids—often with the addition of blended fish[144].

Adult pinnipeds thrive on good quality fish such as herring, smelt, and capelin. Pup formulas can also help nourish older animals during the initial phase of critical care, but the process is time-consuming and expensive, and difficult because it requires tube-feeding, which most adults will resist. As soon as possible, replace formula with a gruel[155] of ground fish, water, and supplements, or better yet, whole fish, which the animal can take on its own. Those that refuse may be force-fed, but the procedure is difficult and dangerous for both the animal and attendant. It may be necessary to use a mild sedative on an aggressive seal when no safe option is available, but as a routine, this is impractical. An adult that will not eat on its own can be impossible to deal with.

5.9.3. Disease and Injuries

Virtually every new arrival harbors microorganisms that are normally harmless but can cause disease (e.g., pneumonia) when the animal is weak or stressed. For that reason, some veterinarians place strandlings on a preventive antibiotic program. Consider whether bombarding a seal pup with a cocktail of drugs will improve its chances of survival or simply make it more dependent on human care, and whether your stranding center may be contributing to the growing problem of antibiotic-resistant organisms. A more judicious approach to medication may be warranted.

A few microorganisms are inherently pathogenic (e.g., *Leptospira*, influenza virus, and morbillivirus), and infected animals must be isolated from all others in the facility. Because time and special techniques are required to identify these agents, **quarantine all new arrivals while health assessments are made**.

Parasites that seldom affect a healthy pinniped can wreak havoc on a debilitated strandling. Nematodes in the stomach and lungs can cause ulcers and pneumonia; even nasal mites and lice can become troublesome. Some stranding centers treat for parasites on a broad scale; others select specific cases for treatment. What is

certain is that nearly every animal beyond the age of a newborn, and sometimes even those[20], will have parasites.

Pinnipeds sometimes strand with physical injuries from bites (e.g., sharks, dogs, or conspecifics), entanglement (e.g., netting, line, or marine debris), gunshot, or other trauma. Wounds to soft tissue and bone can be so extensive that healing to the point of recovery may take many months. Such cases usually require an abiding commitment to long-term (sometimes permanent) care and may ultimately restrict the space and resources available for animals with a better chance of recovery[127]—something to bear in mind when making tough decisions on the beach.

5.10. RELEASE FOLLOWING RECOVERY

5.10.1. Criteria

Release only those animals that have a reasonable chance of leading a normal life and will not endanger the health of the wild population[127,150]. The candidate must be clinically healthy, well-nourished, free of transmissible disease, well coordinated, and active. Clinical evaluation should include screening for pathogens of both general (e.g., PDV, CDV) and regional (e.g., *Leptospira*) concern, as well as for organisms potentially acquired from contact with terrestrial animals, including humans (*see* **12.2.2**). Frozen serum from samples collected at admission and again just before release are valuable for future studies on the sources and movements of pathogens[150].

An ideal pinniped rehabilitation program would prepare animals for life in the wild, complete with a transition to live prey, but on a large scale, this is costly and impractical. At the very least, caretakers strive to minimize rehabilitation time and reduce human dependence while encouraging the animal to socialize with its own kind. Adopt the basic rule: **do not treat candidates for release as pets**. The longer a pinniped is held, the less its chances of readjusting to the wild[127].

Synchronize a pinniped's release with seasonal or annual cycles in the wild population. Most pinniped species have inshore-offshore or north-south movements or migrations that are linked with environmental conditions such as food availability and ocean temperatures, and with breeding or molting cycles. In the U.S., pinnipeds are released with the approval of NMFS (FWS for walruses).

5.10.2. Observing and Monitoring (*see also* 13.2)

Marking or tagging a released animal is the only reliable way to know where it is, how long it survives, and if it restrands. Tagging animals that marginally meet release criteria provides valuable information for refining release programs.

Passive tagging methods[78,90] include marking with dye or bleach (on the head or back), flipper or head tags, and branding. While cost effective, such marks or tags may fade over time, may be lost from the flipper (i.e., cattle tags) or with the molt (e.g., head tags, dye markings), and are visible only at close range. Flipper tags are required for all pinnipeds released in the U.S. (Fig. 5.6).

Active tags[90] transmit or record telemetry data and in some cases provide biological or behavioral information. Radio tags (VHF or satellite) transmit signals to either hand-held or satellite receivers. The range for VHF tags is up to 5 km for land- or water-based tracking; satellite transmitters are more expensive but have unlimited range. Archival tags record data on animal behavior (e.g., dive patterns) and environmental conditions but must be recovered from the animal or after automatic release. Active monitoring offers information not only about the individual's survival and the success of rehabilitation programs[90], but also about behavior, habitat use, and migration patterns. Monitoring studies add yet another element of cost to the stranding program but are nonetheless fundamental to the entire operation. The most efficient approach to monitoring is to focus resources on an intensive surveillance of a few animals rather than a superficial attempt on many.

5.11. EUTHANASIA

In the U.S., euthanasia of pinnipeds can be carried out only by a trained individual under the authority of a qualified veterinarian or other licensed personnel; it is usually accomplished by lethal injection of barbiturates or other agent normally used to euthanize domestic species (*see also* **6.12**). If injection is impractical, larger animals (e.g., elephant seals and some sea lions) are best dispatched by firing a high-velocity bullet into the brain[109]. The technique requires skill, training, and legal authorization for the weapon and should not be considered an option on a busy beach. **Although the risk is uncertain, carcasses containing high concentrations of euthanasia solutions should be incinerated, composted, or buried in approved sanitary landfills to prevent accidental poisoning of scavengers** (e.g., dogs, coyotes, gulls, ravens, and eagles).

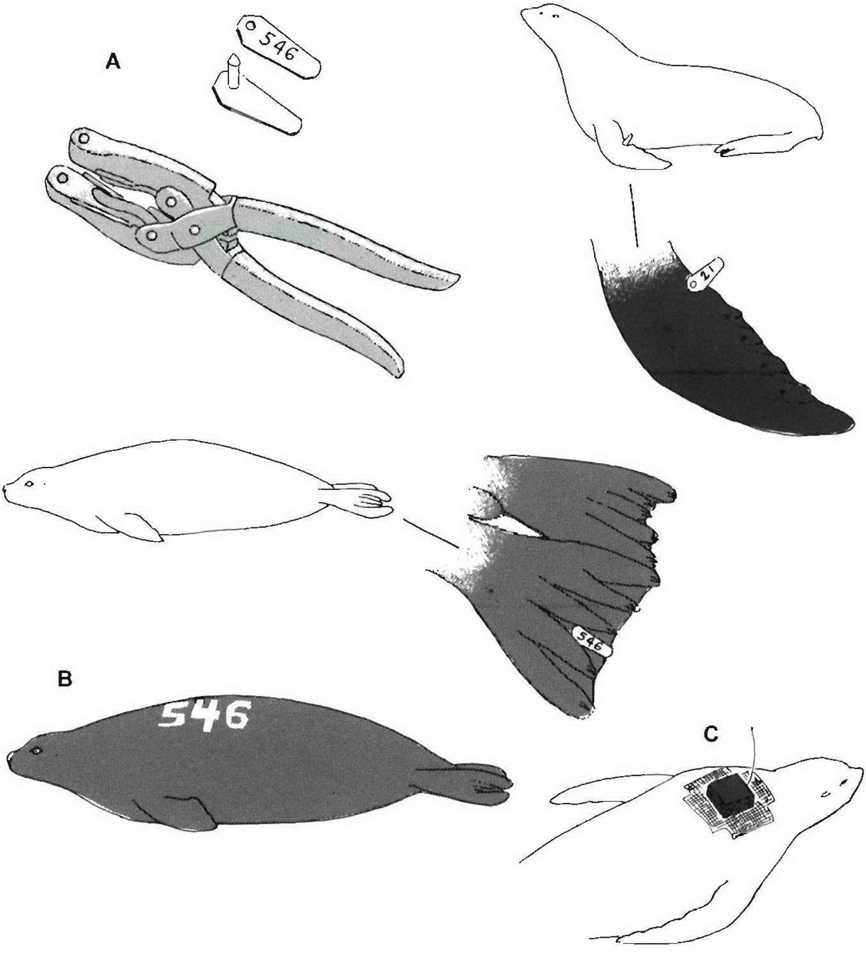


Fig. 5.6. Some methods for tagging pinnipeds before release. **A.** Plastic cattle ear tags, or rototags, are commonly used, easy to apply with special pliers, and have a long retention time. Tags are attached to the hind flipper of phocids (between the third and fourth digits) and to the foreflipper of otariids. Slightly rounding the point on the male half of the tag before application will reduce later irritation to the flipper. A disadvantage of this tag is its small size, making it difficult to sight. **B.** Marking with dye (such as lanolin-based sheep dye, human hair dye), quick-drying paint, or peroxide bleach on the top of the head or back is fast and harmless (be careful of the eyes). The marks are highly visible, will last until the next molt, and are suitable for short-term observation. **C.** Satellite or VHF transmitters can be mounted on a mesh base, which is attached with marine epoxy to the fur of the back between the shoulders, or on the top of the head. These tags will be lost during the molt. (*See also* **13.2.**)

Chapter 6
Cetaceans - Single Strandings

6.1. BIOLOGY

6.1.1. Anatomy and Physiology[50,141,157]

The **Cetacea** are a diverse group, with fossil evidence dating back more than 50 million years. All living families of **toothed** (suborder **Odontoceti**) and **baleen** (suborder **Mysticeti**) whales had evolved by 5 to 25 million years ago[13]. Their closest terrestrial relative—perhaps the hippopotamus—is still a subject of debate[81,131].

Cetaceans have fusiform bodies (Fig. 6.1), with paddle-like **flippers** used for steering, balancing, and stopping. Forward movement is powered by the upward and downward movements of the tail, or **flukes**. Most species have a **dorsal fin**, which serves as a stabilizer. The flukes and dorsal fin consist mostly of dense connective tissue but no bone. Streamlining is aided by smooth, rubbery skin generally lacking glands and hairs, a thick layer of blubber, and the absence of protruding ears, hind limbs, and male external genitalia.

Odontocete **teeth** are usually closely spaced, uniform in shape and size, and bear growth rings in longitudinal section that are useful for estimating the animal's age[143]. Instead of teeth, mysticetes have a series of **baleen plates** suspended from each side of the upper jaw (Fig. 10.16). Hair-like bristles on the inner edges of these keratinous plates intertwine, forming a sieve that filters food from the water[148]. The color, number, and length of the plates are distinctive for each species (*see* **15.2**).

The nose, or **blowhole**, is located on top of the head, somewhat to the left of the mid-line in odontocetes. The external nostrils are paired in mysticetes and single in odontocetes. The nasal passages of the latter contain an interconnected series of **air sacs** used in sound production[114,177]. A unique arrangement of the larynx allows

odontocetes to swallow and breathe at the same time. The **lungs** are symmetrical, without external lobulation, and turgidly elastic. There is a well-defined lung-associated lymph node. The respiratory system and thorax, and the cardiovascular system, are highly adapted for diving.

The **cardiovascular system** is adapted for regulating body temperature by means of the **periarterial venous rete**[164], or countercurrent heat exchangers. Each artery at the surface (particularly evident in the flukes, flippers, and dorsal fin) is surrounded by a network of veins, all encased in a rigid channel of connective tissue underlying the dermis. To retain body heat, arterial blood flows to the surface under low pressure and returns along the surrounding network of veins, which absorb heat from the central artery, minimizing heat loss through the skin. To shed heat, arterial blood flows under high pressure, collapsing these veins against the rigid tunnel walls, and returns instead by veins that lie closer to the skin's surface. The vessels in the flukes are the usual sites for blood sampling (Fig. 10.3).

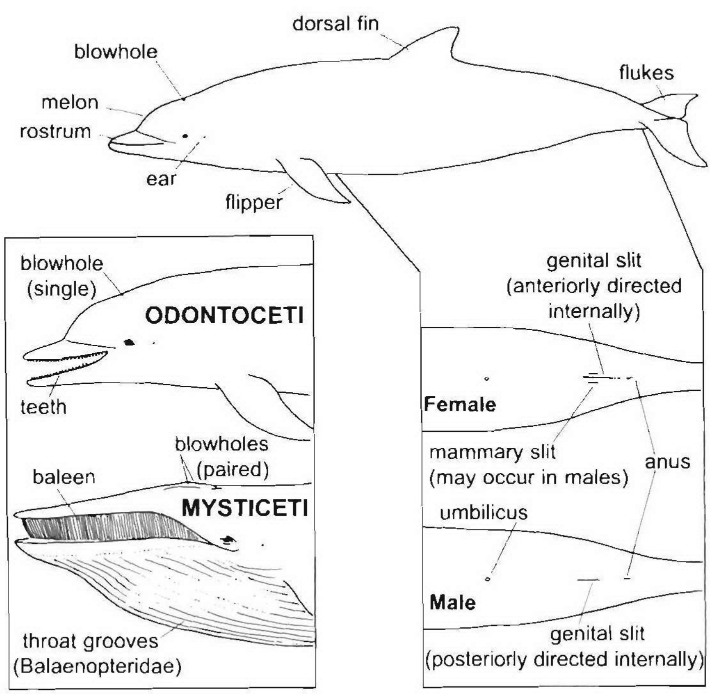


Fig. 6.1. External morphology of toothed (odontocete) and baleen (mysticete) whales. The genders can be distinguished by differences in the configuration of the genital fold. The male usually has two openings, one behind the other, separated by a bridge of tissue. The female has a longer, more prominent slit, which encompasses the closer-spaced genital and anal openings and is flanked by a small slit on each side containing the nipples. An object inserted into the genital opening of a female will be directed toward the head, and in a male, toward the flukes. **Note:** in male *Phocoena* and *Kogia*, the genital aperture is much closer to the umbilicus than to the anus.

The **gastrointestinal tract** has some unusual features. The **esophagus** is penetrated dorso-ventrally by the laryngeal tube. Food must pass to either side of this structure to reach the generally **three-chambered stomach**. (In pygmy sperm whales, the left side of the esophagus is a blind pouch, and food passes to the right of the laryngeal tube[186].) Digestion begins in the first stomach (forestomach), actually an enlargement of the distal esophagus, aided by enzymes and hydrochloric acid that back in from the second (fundic) chamber. Excess undiluted acid can produce ulcers in all chambers (particularly the first), a condition often seen in starving strandlings. The third (pyloric) stomach secretes mucus and prepares the food for intestinal digestion. (The pyloric stomach of beaked whales consists of a series of sac-like chambers or pockets; these species also lack a forestomach[116].)

In odontocetes, the first two stomach chambers often contain nematodes, while the second and third chambers may contain grape-like mucosal protrusions, each containing the stalked trematode *Braunina cordiformis*. The odontocete intestinal tract is not visibly organized into small and large intestines and, in small animals, can measure 20 to 30 m in length.

Other notable features include the absence of a gall bladder, a peculiarly small, firm spleen—sometimes with one or more accessory spleens, and a long chain of large mesenteric lymph nodes. The kidneys are elongated and lobulated, and the urinary bladder small. The testes are intra-abdominal and lie ventral to the kidneys. Veins carrying cool blood from the dorsal fin and flukes are juxtaposed to arteries supplying the testes, providing the cooling necessary for production and storage of viable sperm under otherwise unsuitably high body temperatures[158]. In some species, including *Phocoena*, the testes become so enlarged during the mating season that they exceed the kidneys in size and weight.

6.1.2. Natural History[24,31,108,145,189]

Life histories vary widely among species and even among stocks. Some factors, including age at sexual maturity, lactation period, and calving interval, are also influenced by external conditions such as population density and food availability, and are therefore subject to change.

The smaller **odontocetes** have shorter life spans and accelerated reproductive cycles compared with larger species. The little harbor porpoise, with a life span of only 7 to 15 years, becomes sexually mature at 3 to 4 years, and has a gestation period of 10 to 12 months followed by about 8 months of nursing[64,150]. Sperm, killer, and pilot whales, in contrast, may live more than 60 years. They reach sexual maturity at 8 to 10 years, pregnancy lasts 14 to 16 months, and calves may nurse for 2 years or longer; females of these species may have a long post-reproductive life[91]. Calves of these and other social species may remain with their mothers in a stable group for many years[138].

Baleen whale reproduction is synchronized with annual migrations between low-latitude winter calving grounds and high-latitude summer feeding areas. In contrast with the large odontocetes, these massive animals generally mature relatively young (4 to 10 years), carry the fetus for only about 10 to 12 months, nurse for a brief 4 to 10 months, and live 50 to 80 years or more. Bowhead whales may reach a far greater age, possibly 100 to 150 years[66].

The **social structure** of odontocetes is diverse. Some species, such as harbor porpoises, live alone or in pairs. Others, spinner dolphins for example, form highly organized schools that provide the benefits of cooperative foraging, protection from predators, and a safe neighborhood for rearing young. **Not all highly social species mass strand, but mass strandings always involve social species**, such as pilot whales, sperm whales, and false killer whales (*see* Chap. 7). Baleen whales have a different social organization and, except for mother-calf pairs, appear to lack the binding dependence evident in odontocete schools. They occur alone or in loose aggregations, with behaviorally interacting units of about 2 to 6 animals. Circumstances (e.g., ice entrapment) have forced small groups of mysticetes to founder ashore, but in the true sense, these animals do not mass strand.

Most odontocetes feed primarily on schooling fish and squid; many also eat shrimp, crabs, and bottom-dwelling fish and invertebrates[23]. Animals of the same species may have definite food preferences. For example, some pods of killer whales feed exclusively on fish, while others prefer marine mammals[7,109]. Mysticetes are adapted to foraging on prey that can be engulfed and strained from the water—dense patches of crustaceans, such as euphausiids (krill) and copepods, and small schooling fishes such as capelin and menhaden[148]. Gray whales, unique among mysticetes in feeding behavior, scour the bottom in search of benthic invertebrates[129].

6.1.3. Distribution

More than 50 species of cetaceans occur in North American waters (*see* **15.2** for species accounts and general references), but only some are found predictably in specific areas[22]. Fin and sperm whales and Risso's dolphins, among others, are wide-ranging. Some species are coastal year-round (e.g., gray whales, harbor porpoises, some bottlenose dolphins), while others come inshore periodically (e.g., long-finned pilot whales), during calving or migration (e.g., beluga whales, North Atlantic right whales), or even diurnally (e.g., Hawaiian spinner dolphins). Pelagic species such as beaked whales may be seen at sea so rarely that their descriptions rely entirely on stranding records.

Topographic and oceanographic conditions influence the coastal cetacean fauna. The inshore waters of the warm, shallow **Gulf of Mexico** are virtually uninhabited by baleen whales at any time of the year, although Bryde's, fin, and

humpback whales are sighted occasionally in deeper (>100 m) waters offshore. The **Caribbean Sea** is occupied year round by many species of cetaceans and seasonally by others[118]. Here, the distribution of humpback whales, one of the most commonly observed species, is determined by requirements for calving: warm waters with protection from heavy seas.

On the **Atlantic coast**, the Gulf Stream occasionally brings warm temperate species such as the bottlenose dolphin and dwarf sperm whale as far north as the Canadian Maritimes, while the broad shelf keeps pelagic species further offshore. Inshore waters north of Cape Hatteras are influenced by the Labrador Current and are home to cold-water species such as the harbor porpoise and Atlantic white-sided dolphin.

The steep, rocky **Pacific coast** allows pelagic species, such as the short-finned pilot whale, close to shore, while the California Current brings such cold-water forms as the harbor porpoise as far south as southern California. Cetacean diversity along the California coast fluctuates, with more warm water species present during periods of El Niño[17].

Northern waters are a permanent home for some species, while others visit only during the summer. The bowhead, narwhal, and beluga are more or less confined to **Arctic and subarctic waters**, the beluga being the most wide-ranging of the group. Wanderers from the isolated St. Lawrence River stock occasionally reach Nova Scotia, New England, and even Long Island Sound[140]. During the summer, blue, fin, minke, sei, right, gray, and humpback whales move into northern feeding grounds.

The **Hawaiian Islands** are an archipelago of steep-sloped volcanic cones with enough coastal shelf to support only small numbers of resident cetaceans. Nearshore species include a wintering population of humpback whales, resident communities of bottlenose dolphins, and the pelagic Hawaiian spinner dolphin, which moves into coastal waters during the day[10]. A variety of pelagic species are found in nearby waters[132]. Some, including short-finned pilot whales, pygmy killer whales, rough-toothed dolphins, and pantropical spotted dolphins, are common year-round.

Population size is not easily determined, particularly for pelagic stocks. Populations of baleen whales in North American waters are estimated to range from less than a hundred (e.g., North Pacific right whale), to a few hundred (e.g., North Atlantic right whale) or thousands (e.g., bowhead whale), to tens of thousands (e.g., humpback, fin, and gray whales)[179]. A species abundant in one area may be in peril in another (e.g., western Arctic vs. St. Lawrence River beluga stocks[147,169]), depending on regional factors such as habitat degradation, patterns of exploitation, fisheries interactions, and oceanographic regime shifts.

6.2. MORTALITY

6.2.1. Natural Mortality

Little is known about natural mortality in most species of cetaceans. With some notable exceptions[15,138], long-term observations on cetacean populations are not feasible. Instead, information has come from stranded animals[33,74,84], those harvested commercially[30], and some taken incidentally in fisheries[144,185].

Following the general mammalian pattern, **mortality is high in the very young, decreases sharply with maturity, and increases again in old age**[149]. Species that provide longer maternal care have greater juvenile survival[137], and mortality rates seem higher in males than in females in species presumed to be polygynous (i.e., dominant males mate with a number of females), including pilot and sperm whales.

Environmental Conditions, Trauma, and Predation

Some mortality is directly related to **environmental conditions**. Cetaceans in high latitudes that become trapped in ice may die of starvation or fall victim to predators or hunters. As many as 3,000 beluga whales at one time have met this fate[26], as have narwhals, bowheads, and white-beaked dolphins[78,167]. Blue whales and other cetaceans along southwestern Newfoundland are sometimes trapped in ice and pushed ashore by strong winds[166]. Unusual strandings have also coincided with hurricanes and other severe storms[7,119].

Many cetaceans come ashore emaciated following debilitating injury or illness. **Starvation** due to prey depletion may be difficult to distinguish in animals other than calves prematurely separated from their mothers. Reduced food availability was a suspected factor in the deaths of hundreds of gray whales that stranded from Mexico to Alaska in 1999 and 2000[124].

Toxins produced by marine algae and accumulated in fish or invertebrates can poison and kill cetaceans. In 1987 in Cape Cod Bay, at least 14 humpback whales died after eating fish contaminated with **saxitoxin** produced by the dinoflagellate *Alexandrium tamarense* (responsible for paralytic shellfish poisoning in humans)[73]. **Brevetoxin**, produced by the "red tide" dinoflagellate *Karenia brevis* (formerly *Gymnodinium breve*), was a likely factor in the U.S. mid-Atlantic coast bottlenose dolphin die-off in 1987-88[67] and in more recent dolphin deaths along northwestern Florida[184]. In California, **domoic acid**—a neurotoxin produced by the diatom *Pseudonitzschia* spp. and accumulated by animals such as krill, anchovies, and sardines—has killed hundreds of California sea lions (*see* **5.2.1**) and has been implicated in the deaths of gray whales and common dolphins[110,184]. Blooms of *Alexandrium* and *Pseudonitzschia* have also been linked to cetacean mortality in the Gulf of California and along the Pacific coast of Mexico[135].

Chronic exposure to these toxins may affect population health. Over time, brevetoxin may impair immune function, increasing susceptibility to disease[174]. For endangered North Atlantic right whales feeding on contaminated zooplankton in the southern Bay of Fundy, where dinoflagellate blooms are common, chronic exposure to saxitoxin might impair diving and foraging, and increase vulnerability to vessel strikes[49]. In areas prone to *Pseudonitzschia* blooms, prey species from krill to fishes can concentrate domoic acid, placing baleen and toothed whales at risk of chronic ingestion of this toxin[12,106].

Predation on larger cetaceans is generally limited to the young, old, or those weakened by injury or disease. Scars and bite wounds are evidence that sharks prey upon some populations of smaller odontocetes[32,80]. Mammal-eating killer whales include other cetaceans[86]—even young killer whales[7]—in their diets. Though unlikely to cause death, bite wounds from cookiecutter sharks may contribute to debilitation[65].

Infanticide has been documented in bottlenose dolphins along the central U.S. Atlantic coast[47] and in Scotland[142]. Scottish stranding networks have also documented harbor porpoise mortality caused by bottlenose dolphins with no apparent evidence of predation[142].

Parasites, Pathogens, and Disease

Nearly every cetacean beyond the age of a newborn has **parasites**[36,70,74] (Fig. 10.27-10.28), a few of which may be acquired *in utero*[37,87,152]. The role of parasites in disease and mortality is not always clear. Small respiratory tract nematodes of the genus *Stenurus* are commonly found in the auditory or eustachian tubes, middle ears, and cranial sinuses—sometimes by the thousands—with little apparent effect on body condition[54,117]. There is no firm evidence that these parasites cause strandings. Others, however, have been clearly linked to disease and mortality. The lungworms *Pseudalius* and *Torynurus* are commonly associated with secondary bacterial infections and severe pneumonia in some harbor porpoise populations[9,87]. Aberrant migrations of the trematode *Nasitrema* through the brain have been linked to strandings of several species of odontocetes, including common dolphins along the North American Pacific coast[154]. The large nematodes of the genus *Crassicauda*, some of which may exceed 7 m in length[74], are among the most harmful to the host. Crassicaudids infecting the cranial sinuses cause bone damage[144], while others injure renal blood vessels and mammary tissue to an extent that may impact population health[71,104]. Protozoans are generally harmless, although opportunistic forms (e.g., *Toxoplasma gondii*) can further debilitate animals already weakened by other pathogens, such as morbillivirus[40,121,152].

Cetaceans can be found with cardiovascular problems, lung diseases not associated with parasites, nutritional disorders, and tumors, as well as infections caused by a range of opportunistic pathogens[9,20,34,77]. **Bacteria** of the genera *Vibrio*, *Streptococcus*, and *Salmonella*[48,57], for example, are commonly found in healthy animals. As **secondary invaders**, these organisms can rapidly overwhelm individuals weakened by trauma, parasites, viral infection, or other stressors, thereby obscuring the underlying cause of death. Be cautious not to over interpret their presence.

Brucella seems to be one bacterium (or group) that can cause primary disease in some marine mammals, as it does in terrestrial species. First reported in harbor seals, a harbor porpoise, and a common dolphin in Britain[159] and in captive dolphins in California in 1994[52], infection appears to be widespread in cetaceans and generally of little consequence[58,175,183] (*see also* **5.2.1** and Box 12.1). However, *Brucella* infection has been linked to abortion in captive bottlenose dolphins[52,122], reproductive tract lesions in North Pacific minke whales[136], and brain lesions in striped dolphins in Britain[75].

Before the late 1980s, **viruses** had no known role in cetacean mortality. Following the 1987-88 **morbillivirus** outbreaks in European seals (*see* **5.2.1**), a different morbillivirus (porpoise morbillivirus [PMV]) was isolated from stranded harbor porpoises in Ireland[93]. Between 1990 and 1992, the same or a closely related virus (dolphin morbillivirus [DMV]) claimed at least 1,200 striped dolphins—perhaps many more—in the Mediterranean Sea. Dolphins came ashore emaciated, heavily parasitized and, due to the immunosuppressive effects of this virus, often overwhelmed by secondary infections[40,44].

Cetacean morbillivirus (CeMV), now suggested to represent a single species with various host-adapted strains[43], appears to be common in cetaceans worldwide[41,92,182] and was present in several northwestern Atlantic species prior to the European outbreaks[45]. Retrospective studies show that sporadic outbreaks have occurred in southeastern U.S. coastal bottlenose dolphin populations since the early 1980s and that CeMV was a major factor in the 1987-88 U.S. mid-Atlantic dolphin die-off[46,107]. In large populations in which the virus is endemic, such as pilot whales and dusky dolphins[45,181], infection is presumably widespread but of generally little consequence because animals develop immunity through frequent exposure. Outbreaks follow introduction of the virus into previously unexposed populations or into those that have lost immunity over a period of years. Small, fragmented populations—such as coastal dolphins—may be at greatest risk of serious illness.

Other viruses, with varying effects on health, have also been identified from live and dead cetaceans[95,181]. **Poxvirus** is a common cause of generally mild skin lesions and often appears in conjunction with other illnesses or stress. **Herpes-** and **herpes-like virus** infections have been linked to skin lesions and esophageal ulcers in some odontocetes[120] and with fatal encephalitis in a harbor porpoise[94]. **Papillomaviruses**

cause genital and cutaneous warts in a variety of species. Other isolated cases of viral infection have been reported, including an influenza A virus in pilot whales, a hepatitis B virus in captive Pacific white-sided dolphins, and St. Louis encephalitis virus in a captive killer whale. The list of viruses will undoubtedly continue to grow, as will our understanding of their significance to cetacean populations.

Studies in the past decade have revealed a higher incidence and variety of **tumors** in some cetacean populations than previously recognized[72]. These range from multiple benign growths in the fat and mesentery[72] to debilitating tumors affecting numerous organs[21,38,51,53]. Determining the possibly synergistic roles of contaminants (*see* **6.2.2**), viruses, and heredity in the unusual frequency of certain cancers in some populations (e.g., gastrointestinal tumors in St. Lawrence Estuary beluga whales[112]) will require continued, rigorous investigation.

6.2.2. Human-Related Mortality

Trauma

Human-related injury and mortality of cetaceans varies regionally and among species. The majority of human-related deaths result from interaction with fishing gear[133]. **Entanglement associated with coastal fisheries**, particularly gillnets, has driven the vaquita to critically low numbers and is a serious threat to other porpoise species throughout their range[35,84,85]. For the highly endangered North Atlantic right whale, severe entanglements, when added to relatively frequent ship collisions, may be sufficient to prevent population recovery[98].

Some **pelagic fisheries** have serious impacts on offshore cetacean populations. In the North Pacific, spotted, spinner, and common dolphins are taken in purse seines, although in far smaller numbers than in the 1970s[179]. Large-scale driftnet fisheries, particularly in the 1980s, killed thousands of northern right whale dolphins, Dall's porpoises, and Pacific white-sided dolphins annually[133]. In Britain and Europe, winter strandings of common dolphins have been linked to offshore fisheries[100,125].

Vessel strike is a leading cause of serious injury and stranding of baleen whales[103]. Along the U.S. Atlantic coast, vessel strikes account for about 30% of fin and humpback whale strandings, with calves and juveniles most vulnerable[103,192]. The trend for North Atlantic right whales is more alarming: deaths due to vessel strike have more than doubled since 1989 and now account for nearly half of reported deaths[98,103,123].

Entanglement in marine debris is relatively uncommon in cetaceans, particularly odontocetes; rope scars on right whales are likely due to **interaction with active gear** rather than debris[102]. **Ingestion of plastic and other debris**, however, is common in several species, including sperm whales, pygmy sperm whales, and Cuvier's beaked whales, presumably a result of mistaking such material for

squid or other prey[102,170]. In calves and juveniles, ingestion of non-food items may follow pre-weaning separation from the mother[8]. While not always fatal, some items may block or perforate the gastrointestinal tract, leading to slow starvation or sudden death.

Rarely, a cetacean is the victim of a **bullet wound**. In stranded animals, the opening left by an entering bullet may be too small to detect without careful dissection, or difficult to distinguish from damage inflicted by scavenging birds and embedded seashell fragments[79].

Beyond behavioral responses such as avoidance, the effects of **underwater noise** on cetaceans are poorly understood[153]. The previously circumstantial link between unusual mass strandings of beaked whales and military sonar activity[59,168] was strengthened following a mixed species stranding—mostly beaked whales—in the Bahamas in 2000[11] that coincided with prolonged mid-frequency sonar operations. Necropsy findings included bleeding in the inner ear and brain[178]. Evidence suggests that other underwater activities producing extreme sound levels, such as seismic exploration and dredge blasting, might cause similar injuries[111,155]. Additional harm may befall deep-water cetaceans if they react to such disturbances by altering normal diving/surfacing patterns: beaked whales that mass stranded in the Canary Islands in 2002, within hours of intense sonar activity, showed postmortem evidence consistent with acute decompression sickness, or "the bends"[88].

Contaminants[39,139,161]

Cetaceans in many coastal waters are exposed to a wide range of **contaminants**. As long-lived apex predators, they accumulate some of these substances in their tissues, often acquiring levels known to harm terrestrial species. Females transfer some fat-soluble substances to their offspring during lactation and hence have lower levels than males of the same age[1]. While cause-and-effect relationships have not been established in cetaceans, organochlorine-induced endocrine disruption in other species can have complex effects on physiology, development, and immune function. Heavy contaminant burdens in some cetacean populations have been tentatively linked to high rates of tumors, unusual lesions, and reproductive impairment[16]; and studies on captive bottlenose dolphins suggest that high organochlorine levels in milk might impair calf survival[151]. Growing field and experimental evidence supports a causal relationship between chronic exposure to certain organochlorines and impaired immune function in at least some species of cetaceans[89,101].

Large-scale mortalities from anthropogenic contaminants may be difficult to distinguish from die-offs due to other causes, such as harmful algal blooms. In 1995 in the northern Gulf of California, several baleen whales and several hundred dolphins died from cyanide poisoning, which was linked to chemical tracers used in smuggling activities[56].

Cetaceans are less vulnerable to **oil spills** than other marine mammals[68]. They are unlikely to remain at the surface—or in the vicinity—of a spill and, except for the fringes of a mysticete's baleen plates, have few surfaces to which oil might adhere. Spills, however, like other forms of pollution, degrade habitat, can influence prey abundance and quality, and may increase stress and susceptibility to disease.

6.3. STRANDING PATTERNS

Coastal animals that reside in an area or migrate through it seasonally have a stranding pattern that is somewhat predictable and consistent[115]. Bottlenose dolphins strand throughout the year in the southeastern United States, whereas newborn gray whales are likely to come ashore in the lagoons of Baja California only during the winter calving season. These trends have a long history that is rooted firmly in the biology of the species. More recently, traditional patterns have become complicated by human activities that are less direct and not always predictable—for example, a coastal fisheries operation that, when in full swing, may have a serious impact on local cetaceans[60]. In some areas, changes in water temperatures associated with climatic anomalies (e.g., El Niño) or global warming influence both species distribution and stranding patterns[17,18].

Stranding patterns are not as evident for **pelagic species**, although correlations with topography, tides, storms, geomagnetic disturbances, and other factors have been proposed (*see* **7.1**). Some species follow the inshore migration of prey. Long-finned pilot whales, for example, pursue squid into shallow waters of Cape Cod Bay during the autumn and early winter and tend to strand during these seasons. These events also correlate somewhat with storms that combine with monthly peak tides. Seasonal pelagic fisheries may also influence the numbers of carcasses found ashore[100,125].

Animals that strand in a cluster over a period of days may be victims of poisoning[56,73], infectious disease[44], local fisheries operations[125], or unusual environmental events[11]. These episodes can be of such short duration that the underlying cause may no longer be evident by the time the investigating team takes action.

The mother/calf bond is strong and may remain so long after the end of lactation[27,31]. Consequently, if both come ashore, it may be impossible to determine which led the way. Young males of some social species may appear alone at predictable times of the year. For example, juvenile Atlantic white-sided dolphins strand along the U.S. northeast coast during the fall, suggesting they may have been lost or displaced from a bachelor group. Yearling bottlenose dolphins may come ashore alone after being displaced from the herd during the breeding season.

Animals that wander **beyond their normal range**, fail to migrate with the onset of winter, or make unusual appearances in bays or far up rivers always generate public interest. A single male beluga whale, apparently a stray from the St. Lawrence River population, resided in Long Island Sound for over a year before it died from a gunshot wound[140]. "Rascal," a young male bottlenose dolphin that stayed behind when other dolphins headed southward from their summer feeding grounds off northern Virginia in the fall of 1988, was finally "rescued," placed into a facility, and released months later. Rescue efforts following the ice entrapment of three gray whales in Alaska in 1988 became an international event[163]. **Public sentiment may override any consideration as to whether rescue in such cases is necessary, justifiable, or even possible.**

6.4. STRANDING RESPONSE

6.4.1. Jurisdiction

In **U.S.** waters, all cetaceans fall under the jurisdiction of the National Marine Fisheries Service (NMFS) and are protected by the Marine Mammal Protection Act of 1972. The sperm whale and the vaquita, as well as all baleen whales except minke, Bryde's, and gray whales, are also listed under the Endangered Species Act. Stranding response to these species requires additional permits. By decree of the **Mexican** federal government, all waters within that country's jurisdiction are refuges for cetaceans; stranding response requires a permit. In **Canada**, marine mammal management is the responsibility of Fisheries and Oceans Canada (*see* **2.2**); response to stranded cetaceans is generally limited to rescue or carcass salvage and necropsy.

6.4.2. Evaluating the Event

Before taking action on an animal that is close to shore, stop to evaluate the scene. Attempt to determine the species (*see* **15.2**), the approximate size, distinguishing features (e.g., markings or tags), and respiration rate, and look for other animals in the area and any signs of unusual behavior or conditions (*see also* **7.4.2** and Box 10.1). If there is no obvious injury or disability, but—after discussions with appropriate coordinators and experts—intervention is deemed necessary, it may be possible to direct the animal back to sea. Under calm conditions, this can be done using boats (ideally with propeller guards) with experienced operators and chains of people to herd the animal, by creating disturbance and underwater noise (e.g., slapping the water's surface or striking objects together below it, or using boat engines) (Fig 6.2). Under the best conditions, it is difficult to sustain the effort needed to herd an animal a long distance, and there is a good chance it will come ashore somewhere else, probably close to the original site. **If the animal is seriously debilitated, no amount of effort is likely to avert the eventual stranding.**

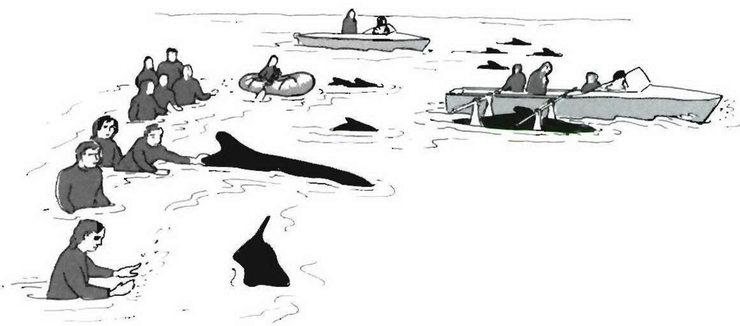


Fig. 6.2. Techniques for stranding prevention and returning cetaceans to sea, including use of underwater noise, manual reorientation, herding with small craft, and towing in a sling or stretcher.

The response team's appropriate course of action will depend on the animal's size, age, and health; available support and environmental conditions; and the time since the animal stranded (*see* **4.3**). The **options** are to release the animal if it is healthy (tag first to allow identification if it re-strands), transport it to a facility for medical attention (a less common option), euthanize it, or let it die naturally. Decisions should be timely and the action swift to relieve the animal of progressive injury and discomfort.

Except for obvious abnormalities, **it is not always possible to judge the health of a cetacean by its outward appearance**. Even sophisticated tests may not reveal the nature of the illness, and such analyses can take more time than the beached victim can spare. When circumstances do not permit an exhaustive physical examination, certain broad assumptions can be made based on an understanding of life history and historical stranding patterns.

Coastal animals such as some populations of bottlenose dolphins, expected to be familiar with the near-shore environment, **usually strand singly only when ill**[34,69] or perhaps orphaned, although they may be occasional victims of an outgoing tide. Unless it's a simple case of refloating, their only reasonable chance for survival is in a care facility. Even then, such efforts may simply postpone the animal's death while depleting the facility's resources and unduly risking the safety of the responders and rehabilitators. Taking in an orphaned calf—even of a small species—is unfeasible for most facilities, and few centers have the capacity to care for larger orphans[4,25,190].

Some offshore animals have characteristic illnesses. Common dolphins off the California coast, for example, may strand because of brain damage caused by the trematode *Nasitrema*[154]; even with good medical care, they have little chance of survival. *Kogia* spp. frequently come ashore along the U.S. Atlantic coast with serious heart disease of uncertain cause[20]—a condition unlikely to respond to

treatment—or after ingesting debris. The successful rehabilitation of one pygmy sperm whale that stranded due to ingestion of plastics involved specialists in ultrasound and endoscopy, in addition to many weeks of round-the-clock care and an estimated 40,000 hours of volunteer help[191].

Many pelagic cetaceans come ashore in apparently good health—or at least free of recognizable disease. Independent juveniles and young adults of smaller species that have been stranded for only a short period of time have a reasonable chance of withstanding the rigors of being returned to sea[160,188,193], although **long-term survival is largely undocumented**.

The larger the animal and the longer it lies on the beach, the less likely it is to survive after release. Nothing can be done to save a whale too large to handle, or one that has suffered prolonged exposure. The animal should either be euthanized (and options for large whales are limited) or left to die naturally.

6.5. APPROACH AND RESCUE

Capturing stranded cetaceans is not an issue unless they are still floating, in which case it may be better to herd them out to sea if they appear healthy. Capturing distressed cetaceans in the water requires specialized equipment and expertise beyond that of most stranding responders[5] and, in the U.S., approval from NMFS. **Even under the best circumstances, cetacean rescue involves some element of risk** (*see* Chap. 12), and the larger the animal, the greater the difficulties and potential hazards. It is better to abandon a rescue attempt than risk serious injury to the team.

6.5.1. Specific Equipment (*see also* **2.5** and Box 2.1)

Much of the equipment required for cetacean rescue is for moving or supporting the animals. Any specimen beyond the size of a small pilot whale will require heavy equipment. (Refer to Fig. 6.3 for help in estimating weight.) Many devices specifically designed for moving cetaceans are cumbersome and impractical in the field. Basic equipment (*below*) will generally prove to be the most useful. Refer to Boxes 6.1 and 6.2 for additional information on items useful for beach and water use.

- foam pads or mattresses
- sheets, towels, or blankets
- shovels
- buckets
- water sprayers
- "space" blankets
- heavy equipment for digging, moving, and lifting (bulldozers, cranes, front-end loaders, trucks, and trailers)
- tarpaulins
- zinc oxide
- ropes
- slings
- stretchers and poles
- inflatable rafts and pontoons

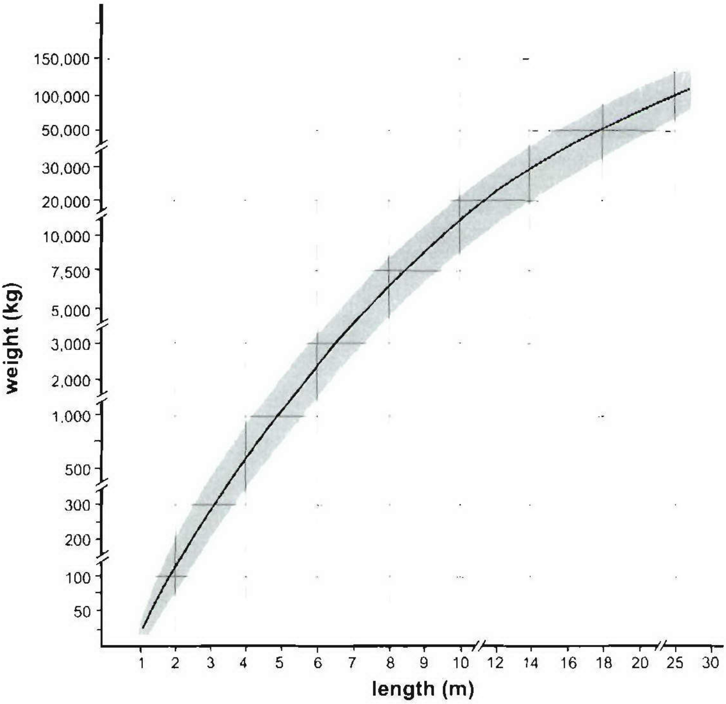


Fig. 6.3. This graph can be used to estimate the weight of a cetacean of any given length. Derived from sources used to prepare Chap. 15, it is based on average to maximum size of species occurring in North American waters. **Note: Do not use this graph as a guide for administering medications or anesthetics:** many stranded animals are emaciated and fall far below this average range, while others, such as heavy-bodied species or pregnant females, may be well above it.

6.5.2. Approach

Observe the animal's behavior and plan the approach. Advance calmly and cautiously from the front or side; avoid loud sounds, abrupt movements, or bright lights. Allow the strandling to become gradually accustomed to your presence. The animal is not likely to be aggressive, but people have been bitten accidentally, and the thrashing flukes of a distressed whale have wrecked more than one knee joint. **Only experienced personnel should approach the animal, keeping well clear of the flukes and mouth.**

Animals may panic. A mother separated from her calf or attempting to protect it may become aggressive. A lone member of a social species may become frightened when separated from the pod. Consider the animal's possible response to your intended actions.

Box 6.1. Equipment for Stranded Cetaceans (*courtesy of* P. Howorth[82])

Stretchers: Use smooth, easily cleaned, non-absorbent material, e.g., vinyl-coated canvas, woven plastic, or netting (line netting with towels or sheeting to reduce skin injury). **Options:** Include openings along sides for attaching a harness or lines to the poles for lifting by crane. Use **stretcher poles** of heavy aluminum tubing; weld ends shut so poles will float (or weigh less) in water. Use a **spreader bar** at each end (made from heavy pipe) to keep poles apart when stretcher is lifted. Remove the stretcher bar and close stretcher poles over each other if the animal is thrashing severely. This will reduce the risk of people being injured while trying to control the animal.

Stretcher racks: Easy to make from heavy pipe. Use for each end of stretcher. For each rack: **1)** assemble 3 pieces of pipe in square "U" with two 90-degree elbows; **2)** screw a tee into the top of each side of upright U; and **3)** slide stretcher poles into tees, with each rack tipped slightly outward at base for stability.

Messenger pole and line: A long metal or wooden pole, sometimes slightly curved or bent, used to pass a "messenger" line under an animal; this line is attached to a heavier towline or to slings, which then can be safely pulled under a beached animal. Paint pole a bright color (e.g., orange) for high visibility.

Padded travel lift strap or hawser: Travel lifts are mobile hoists used to lift boats from the water; when heavily padded, their nylon straps can be used as a towing harness for large cetaceans. Alternately, use a short length of heavy hawser (12-15 cm diameter, too thick to cut into the skin); fit with eyes or rings for attaching a pelican hook (*below*).

Pelican hook: A hinged hook designed to open by a tap from a pole or pull on a trip line; these allow towing bridles to be rapidly and safely disconnected from large cetaceans.

Heavy towline: Depending on the size of the whale and the breaking strength of the line, 10- to 20-cm line (or even larger) can be used to pull an animal off a beach.

6.6. FIRST AID

6.6.1. Determining Condition[128,134,160,172,187]

Evaluating the health of an animal requires progressive steps beginning with observation. Behavioral observations are quick, non-invasive, and can be done by persons with relatively little training. **Behavioral criteria** can be used to assign animals to one of three categories:

1. **Alert** (aware, responsive to environmental stimuli).
2. **Weakly responsive** (responsive only after much stimulation).
3. **Non-responsive** (not responding to noise or touch, e.g., no blink reflex).

Certain types of **human-related injuries** may be obvious, for example, a ship strike that leaves parallel propeller wounds on the back. (Serious internal injuries from vessel impact may not be visible externally.) Injuries due to **entanglement or by-catch** may appear as grooves around the peduncle, net marks, or amputated fins or flukes. Still, species such as harbor porpoises and spinner dolphins may show few obvious indications of fisheries-related trauma[3,99].

A stranded cetacean inevitably develops **respiratory fatigue and distress**. This occurs sooner in larger animals whose chest cavity will be more severely compressed by body weight. Signs include irregular and increased respiratory rate and audible gurgling sounds as the animal breathes. (Up to 6 to 8 breaths/minute may be normal for an excited *Tursiops*; a pilot whale may respire as little as once every minute or so, and a sperm or fin whale every 15 to 20 minutes.) If respirations are slower than expected, a firm splash of water over the (closed) blowhole may stimulate breathing. Extensive bleeding, or frothy or foul-smelling fluid from the blowhole is a sign of critically poor health.

Cardiovascular function can be roughly evaluated without using invasive procedures. Heart rate can be determined using a stethoscope in a very small animal, and sometimes by placing a hand firmly under the axillary region of a larger one. Even under normal conditions, however, the heart rate varies considerably (e.g., from 30 to 100 beats/minute in *Tursiops*) during the breathing cycle. One result of deteriorating cardiovascular function is poor circulation, which makes it difficult to obtain blood samples from the usual peripheral sites (*see* **10.3**). Body temperature control is also reduced when blood cannot be delivered to the extremities, where excess heat is normally shed.

The next assessment level requires handling. Gentle tapping near the eye should elicit a blink (i.e., the blink, or palpebral, reflex). Attempts to pry open the jaw, pull the tongue, or tug the flipper forward should be met with firm resistance. Once the jaw is open, a gloved finger pressed firmly on the gums over the teeth should cause blanching followed by immediate return of normal pink color. A slow return (i.e., > ~ 2 seconds) or bluish discoloration is a sign of poor circulation (*see also* Table 7.1).

Body temperature can be determined accurately enough for early assessment purposes using a deep rectal thermometer. In small to medium-sized animals, normal temperatures are about 36.5° to 37°C. In cold weather, body temperature may drop rapidly below 35.6°C, signaling the onset of **hypothermia** or **cardiovascular shock**. Temperatures above 40°C are critical and above 42°C probably terminal.

If time permits and clinical laboratory services (or a portable analyzer) are accessible, a **blood sample** may reveal conditions that are not readily apparent and can help establish a prognosis. Analysis of serial samples during a prolonged event may be particularly useful; a continuing rise in muscle enzymes several hours after the animal has been refloated, for example, would argue against release.

6.6.2. Supportive Care

General

The time between stranding and the arrival of the rescue team can be used to relieve distress and improve the animal's chance of recovery (Fig. 6.4). The key is to **prevent further injury and keep the animal comfortable while minimizing handling and disturbance**. Avoid touching the eyes, blowhole, or genital area; and do not use the flippers, flukes, or dorsal fin as handles for lifting or rolling.

Protect the eyes and blowhole from blowing sand and moisten with clean fresh or salt water. Gently flush the head area just after the animal breathes when the blowhole is closed. Observe the breathing sequence before doing this. Always apply water from a source close to the skin to **minimize the startle reflex**.

It is easier to keep the blowhole free of water and sand, and presents less risk to the lungs, when the strandling is placed on its belly. This can be done easily with a small animal. For larger ones, use a spade or shovel to dig holes in the sand to allow the flippers and flukes to lie in a natural position. Banking sand or placing other (non-injurious) material alongside the body will reduce the tendency to roll.

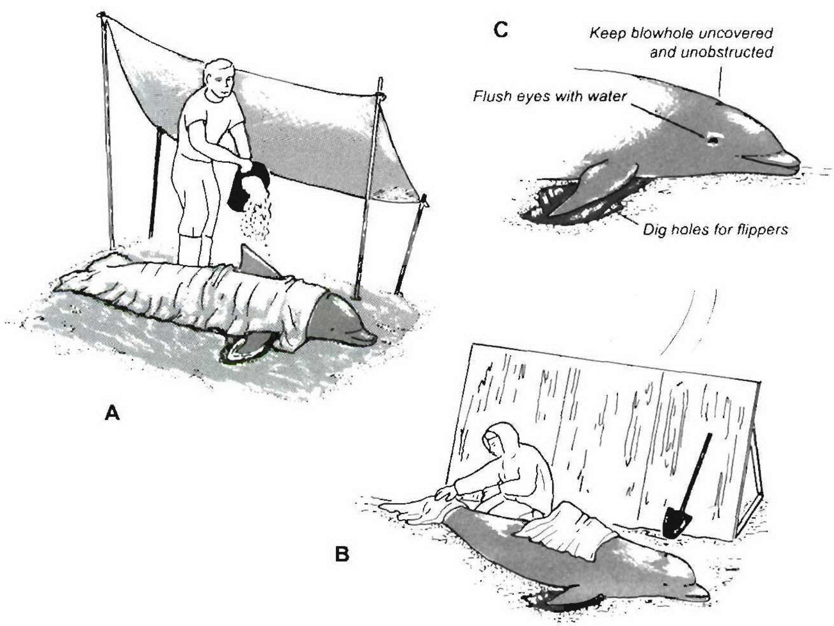


Fig. 6.4. First aid measures on the beach. **A. Summer:** provide shade, drape leaving dorsal fin exposed, and keep moist; dig holes for flippers and fill with water. **B. Winter:** provide protection from wind, cover dorsal fin and flukes with cloths soaked in vegetable or mineral oil, and dig holes for flippers. **C. Always:** keep blowhole unobstructed and eyes free of sand, allow flippers to assume a natural position, and minimize noise and disturbance.

Exposure

Animals on the beach must be protected from the elements (Fig. 6.4). Prolonged exposure to wind and sun can damage the skin and cause overheating at warm temperatures (**hyperthermia**) and **hypothermia** at cold temperatures.

A cetacean on the beach is at risk of **hyperthermia** even on cloudy, temperate days. Dark skin absorbs heat, blubber retains it, and the circulatory system that normally helps to dissipate heat may be impaired. A whale out of water has no other mechanism for cooling. **Minimize the danger of hyperthermia** by draping exposed surfaces except the blowhole with towels or sheets kept moist by periodic wetting. Lighter colored materials have better reflective properties, but in a pinch, items of clothing, newspapers, or even wet seaweed or mud will do; "space" blankets can be used with the reflective side facing outward. If feasible, construct a small shelter over the animal. Heat loss occurs principally from the extremities, which should therefore be kept wet or cooled with ice (wrap ice in towels to avoid direct contact with the skin.). **Be careful when working around the flukes.** A trench dug in the sand around the animal can be kept filled with water through a channel to the sea.

An application of zinc oxide will protect skin from sun and windburn and help prevent dehydration. Oil-based compounds (e.g., lanolin), including those used in sun-tanning products, retard heat loss and may do more harm than good. Skin already damaged should be kept moist, shaded, and protected with zinc oxide, antibiotic ointment, or petroleum jelly.

A good layer of blubber insulates an animal against cold, but cetaceans that strand in cold winter climates can develop **hypothermia** and frostbite. Emaciated specimens, calves, and small species are at greater risk. The diagnosis requires some expertise. On a frigid beach, provide shelter from wind and precipitation, and cover the extremities with a cloth dampened with mineral or vegetable oil.

Protection from Surf

A cetacean in the surf zone may be battered by waves, trapped among rocks, rolled onto its side, or become mired. If the animal is too large to move into deeper water or to higher ground, shift it so it is perpendicular to the water's edge, with the head facing land. In this position, the body offers the least resistance to the surf, and the blowhole is as far from water as possible.

Heavy, struggling animals can become bogged down and trapped in soft sand or mud that eventually fixes them in place. They are then victims of the rising tide and nearly impossible to rescue because of the difficulties and hazards of working in soft sediments. The same may be true of animals that are oval rather than round in cross-section, such as the sperm whale, and so tend to lie on their sides when stranded, suffocating as the tide rises[19].

Lacerations and Injuries

Sharp rocks and seashell fragments can cut and injure a struggling animal as well as the people involved in the rescue attempt. Remove or cover hazardous objects, place padding around the body, or move the victim to a safer place. Efforts to calm or restrain whales under these circumstances are unrealistic. **Never use tranquilizers or sedatives on animals that are to be immediately released.**

There is no proven benefit to medicating an animal that has just stranded and is about to be released. Without opportunity for continued care, a single application of ointment, a bolus of antibiotics, or one feeding of fish has no benefit. However, an animal that faces a longer period out of water before it is released or transported will benefit from prompt medical care to wounds and fluid therapy to maintain hydration.

Stress and Shock[161]

A cetacean on the beach is certainly stressed. Catecholamines are released as one response to stress, i.e., the "fight or flight" reaction. Stimulated by the pituitary gland, hormones (cortisol and aldosterone) from the adrenal gland are also released into circulation[171]. The presumed benefit of cortisol is to ensure a supply of blood glucose and reduce some of the adverse effects of the inflammatory response. The function of aldosterone is probably to maintain salt and water balance. However, an excessive or prolonged release of catecholamines damages heart and skeletal muscle[176]; sustained high cortisol has harmful effects on circulating white blood cells, wound healing, and the immune response; and prolonged high aldosterone causes excessive sodium retention, thereby increasing the animal's thirst for water. **An extreme or prolonged stress response, through damage to the heart, skeletal muscles, and other systems, can cause sudden death or contribute to death long after the stranding[63,176].**

Within a few hours after stranding, some cetaceans show evidence of shock or vascular collapse. Blood pools in the thoracic and abdominal viscera, with effective circulation remaining only to the heart and brain. The rest of the body is largely bypassed, and organs such as liver, muscle, and skin, begin to show impaired function due to lack of blood. Compounds normally metabolized and detoxified by the liver can accumulate to dangerous levels, cortisol and aldosterone among them. Since the animal may appear healthy, **blood studies are required to detect these changes**. Only a long course of intensive care offers some hope of recovery. **Whatever the reason the whale came ashore, the onset of shock further reduces its chance of survival.**

Rescuers have attempted to reduce respiratory distress, circulatory problems, and muscle cramps by periodically shifting the animal's body position and rolling it onto each side for 20 minutes or so, or by placing it on a partially inflated heavy

air mattress or foam pad[42,128,188,193]. If a stretcher is available, floating the animal in shallow water may be helpful. Some rescuers advocate massaging the muscles of the back[156], a procedure that may benefit a small animal but is unlikely to help a larger one with thick blubber. Corticosteroids and other medications may help minimize muscle damage and delay the onset of shock[187].

6.7. HANDLING, LIFTING, AND MOVING

Rescuing an animal means handling, whether to drag it from surf, maneuver it into deeper water, or load it onto a transport vehicle (Figs. 6.5, 6.6, 6.7). **Most procedures are potentially injurious to both the animals and personnel** and should be attempted only by trained staff with adequate support and resources. Six people might be able to carry a medium-sized bottlenose dolphin on a stretcher, but fifteen or more may be needed to move a pilot whale.

Several methods are useful for moving small whales and dolphins. An animal can be placed or rolled onto a tarpaulin or stretcher (Fig. 6.5), then lifted or dragged (Fig. 6.6). Field stretchers should be large and strong enough to carry any reasonably large animal, which means a small one will be safely enveloped within it. When the whale will remain in the stretcher for more than 15 to 20 minutes, provide openings for the flippers (to prevent crushing and overheating) and the genital region (to prevent urine burns) (Fig. 6.7). Once the animal is in the stretcher, make sure no seams or creases press into the skin.

"I've heard the service here is getting better all the time!"

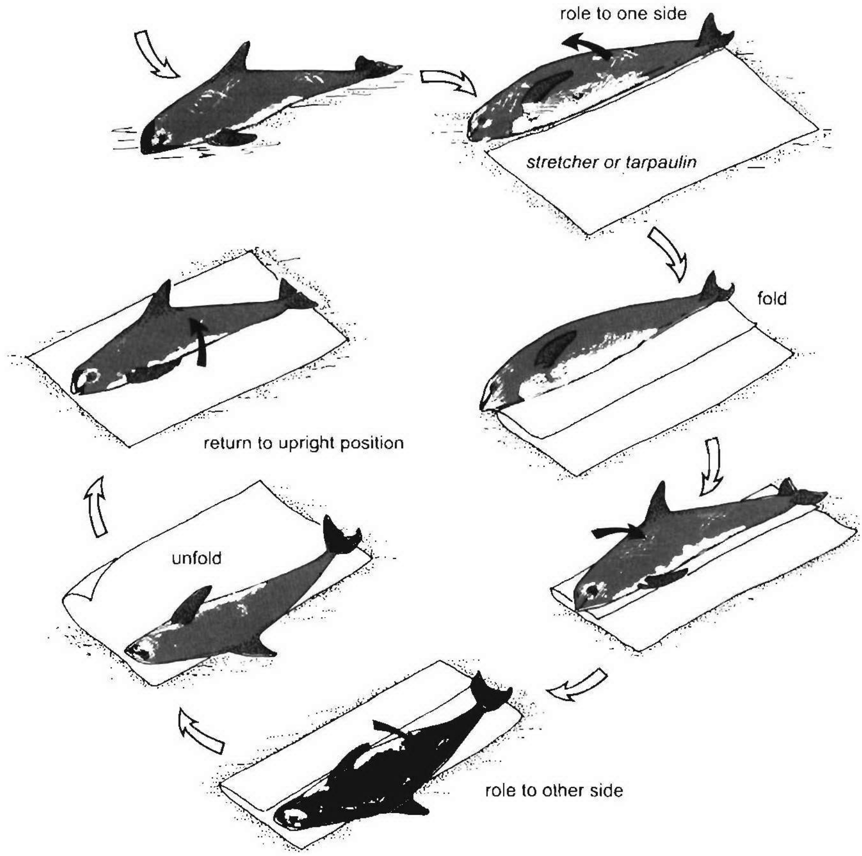


Fig. 6.5. Technique for positioning a cetacean on a tarpaulin or stretcher without lifting.

Dragging is an acceptable option when lifting is impossible. Slings positioned under the body behind the flippers can be used to drag the animal on the beach or to support it in the water (Fig. 6.6, 6.9); on land, extra support under the head may be necessary. Ensure that slings are well padded and wide enough to distribute the pressure sufficiently to minimize focal injury. **Never use naked rope as a sling.** In an emergency, braided hose from the fire department can be used to fashion a sling behind the flippers under the thorax. This is strong enough to tow animals as large as pilot and minke whales[113]. Drag only over smooth terrain from which all obstacles have been removed.

Rolling the animal is not recommended. Any cetacean healthy enough for release can be expected to react violently, and the procedure can damage the flippers or dorsal fin. If an animal is small enough to roll, instead maneuver it onto a stretcher or sling.

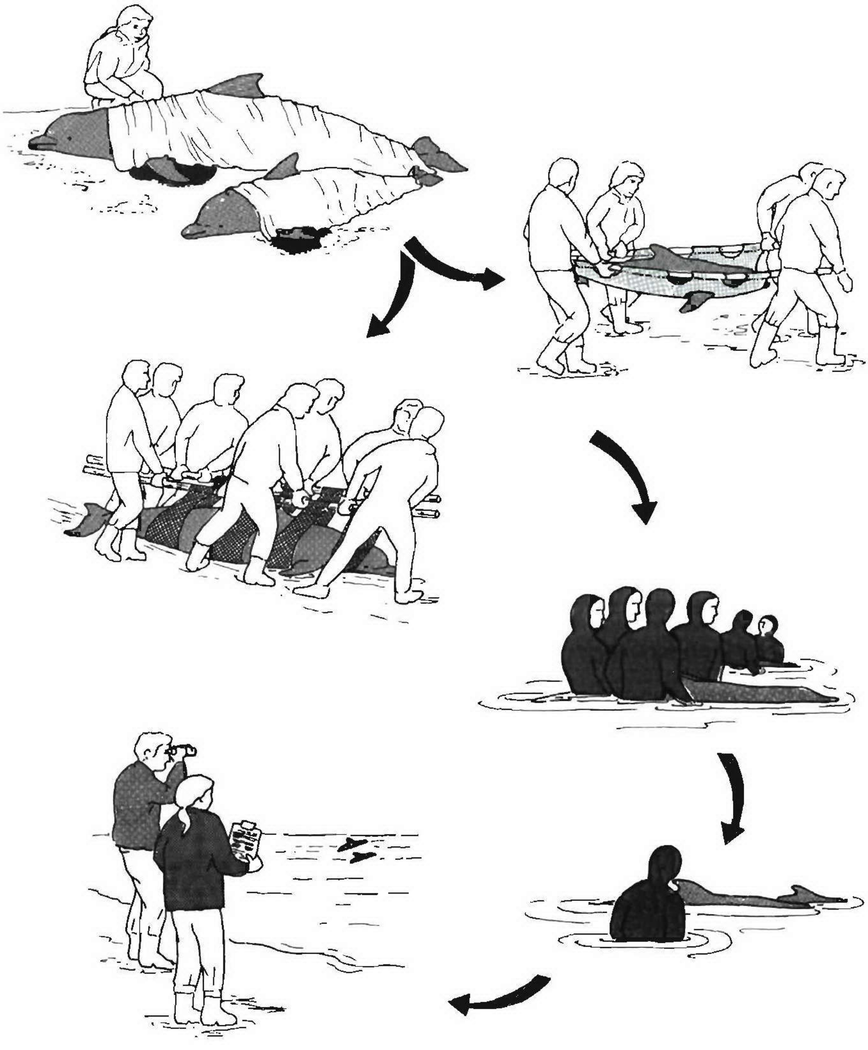


Fig. 6.6. General rescue sequence involving first aid and supportive measures; moving the animal to the water by lifting in a stretcher or dragging with slings; support in the water with gradual acclimation; and observation and monitoring of released animals.

Cranes and other heavy lifting equipment are used for moving large animals and for loading them onto transport vehicles (Fig. 6.7). Secure the animal in the stretcher with enough rope or straps to prevent thrashing, and attach guide ropes or "tag lines" that will allow handlers to hold the stretcher steady. Attempt this only under the direct supervision of experienced personnel. Never stand directly beneath the load.

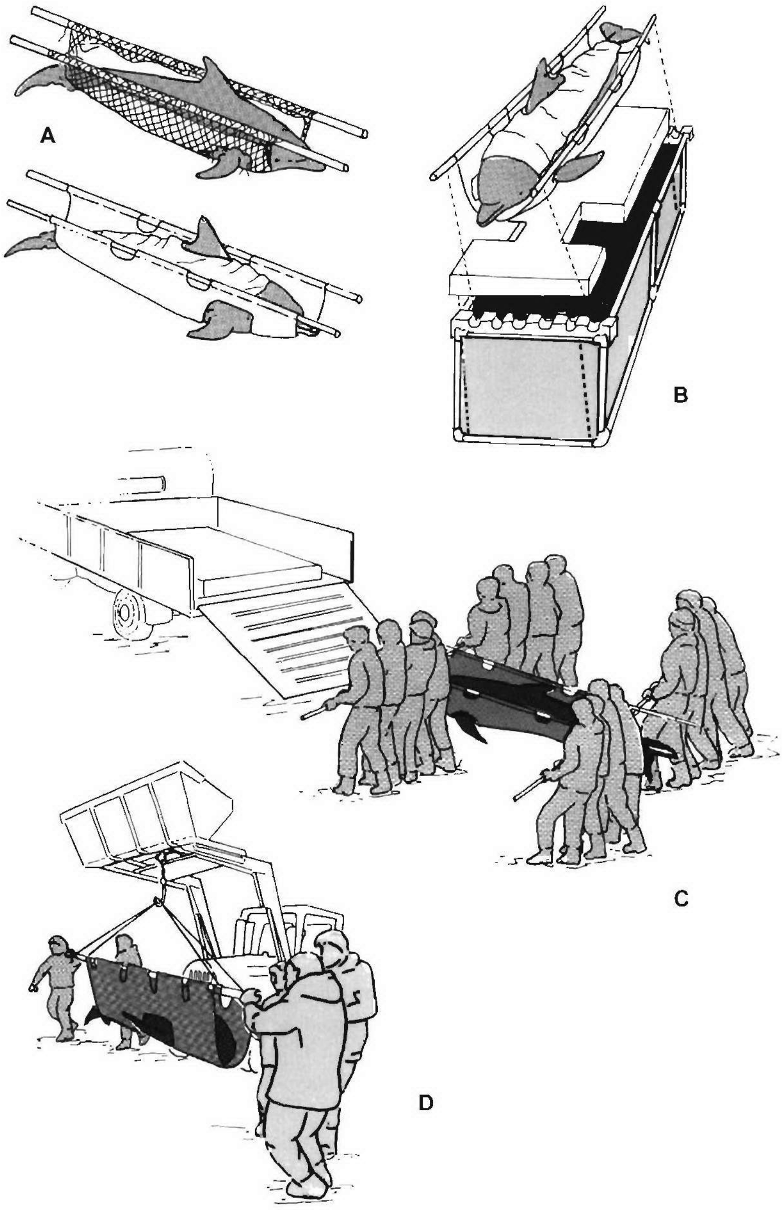


Fig. 6.7. Cetacean transport methods. **A.** Stretchers with holes for flippers. **B.** Specially constructed transport box with foam pad and waterproof liner. **C.** Manual method of moving a small pilot whale onto a foam-padded transport vehicle, using poles positioned cross-wise through stretcher handles to allow necessary support. **D.** Use of heavy equipment to move whales.

6.8. IMMEDIATE RELEASE

6.8.1. General Considerations

For most stranded cetaceans, **a rapid, well-planned release offers the best chance of survival**[130,193]. In many cases (e.g., due to remote location, policy, or lack of facilities) immediate release may be the only alternative to euthanasia or natural death. Coordinate the release with an incoming or high tide, and ensure that personnel and equipment are up to the task. Choose a route with simple access to open water, and that is free of obstacles, by first consulting a hydrographic chart or persons familiar with the area. In some cases, transport to an alternate release site—perhaps many kilometers away—may be necessary. When the weather or tide (e.g., heavy surf) is unsuitable, the animal may be placed in a tidal pond or fabricated pen enclosure and released when conditions improve.

Make every effort to keep a mother and calf together during release. A free-ranging dolphin may remain with her dead offspring for weeks[27], suggesting that returning even a dead calf to the water with its mother may help prevent her from restranding. **Orphaned, dependent young should not be released. Calves whose mothers cannot be verified should be considered orphaned.** Determining whether a calf is still dependent on its mother is not always simple, as size at weaning varies among individuals and is unknown for many species (*see* **15.2**). Calves with neonatal folds or a raw umbilicus, or less than 50 to 60% of the adult maximum size—toward the larger end of the range for most odontocetes—are unlikely to survive without the mother. For most odontocetes, the degree of tooth eruption may be a better indicator of dependency—a calf with only partially erupted teeth is presumed dependent. Mysticete calves must have functional baleen, perhaps at least half the length of that of an adult, to forage effectively.

Lone animals of a social species are candidates for release only when there is a good chance they will regain contact with a herd (*see* **7.6**). Otherwise, euthanasia may be the most humane option.

6.8.2. Marking and Tagging[83,105,165]

Any animal returned to sea should be marked or tagged and the details of its release fully documented (Fig. 6.8; *see also* **13.2**). Only then can observers determine whether the animal survived—at least in the short term—and if the rescue procedures were effective. Dorsal fin tags are easy to apply with the appropriate attachment devices and can be made in various colors, shapes, and sizes. At the minimum, equip every team with a quantity of colored or numbered plastic cattle ear-tags and a small boring device for attaching the tag through the dorsal fin. Freeze brands[128] are effective for long-term marking but are not immediately visible and must be combined with some other type of tag. Radio (satellite or Very-High-Frequency [VHF]) tags provide far more information[29,127]

but are costly and require specialized tracking equipment. Implanting a permanent microchip transponder at the base of the dorsal fin offers a permanent means for identifying any animals that restrand[128]. **Tags and telemetry packages can be applied only by trained personnel and when authorized by permit.**

In addition to tagging, **natural marks (e.g., unusual fin or fluke shapes, or scars) should be photographed** to assist in later identification of restranded animals, or as a way to monitor individuals from small, local populations.

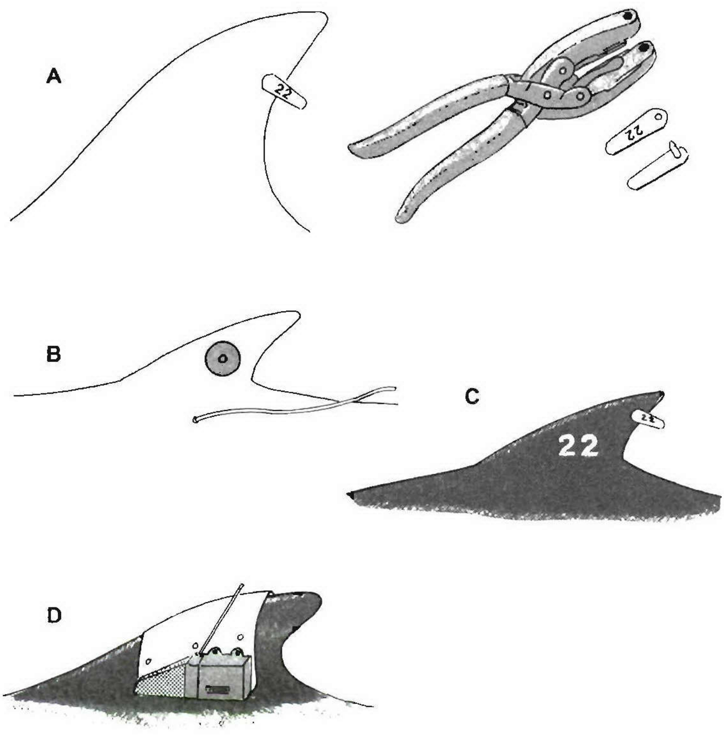


Fig. 6.8. Some techniques for tagging cetaceans. The dorsal fin or ridge is the preferred site both for convenience of attachment and visibility. Skill and experience are required to minimize tissue damage and prevent infection. **A.** Large plastic cattle ear tags, attached with special pliers, can be used to mark carcasses and to tag live animals prior to release. Tags are attached through the trailing edge of the dorsal fin and cause little tissue damage when they are lost. These tags are reliable only for short-term observation. **B.** Other types of markers include a "button" tag, a plastic disk attached by means of a bolt through the dorsal fin, and a "spaghetti" tag, a streamer with a barbed head that is anchored in the blubber. **C.** Freeze-brands on the dorsal fin or on the sides just below the dorsal fin can provide long-lasting marks that are visible from a distance but will not be clear immediately and should be combined with a plastic dorsal fin tag for interim observation. **D.** Satellite or VHF tags can be mounted on a molded plastic "saddle" that is bolted through the dorsal fin and held by nuts made to dissolve in seawater so that the package will eventually be shed. Advanced telemetry packages are smaller and may be attached through the fin with less tissue damage. (*See also* **13.2.**)

6.8.3. Acclimating Animals in the Surf

There is more to releasing a stranded whale than hauling it back to sea. In preparation for release, keep the animal on the beach wet and cool to avoid a quick change in temperature that might evoke a startle reaction. Once in the water, gently support the animal, keeping the blowhole above the surface. One person may be able to handle a harbor porpoise (assuming reserve help is on hand), but more are needed for larger species (Fig. 6.6, 6.9). Acclimation is not complete until the animal is able to surface on its own to breathe. The process can take a long time and puts rescuers at risk of hypothermia. Proper gear (e.g., wet suits) and a relief team must be available (*see* **12.2**, **12.3**). A mother and calf should be acclimated together.

Grounding impairs circulation and can lead to muscle stiffness and eventual curvature of the body. If the latter is noted, release is not appropriate. Gentle side-to-side rocking (keeping the blowhole above water) of an animal that is not fully coordinated when refloated may help restore blood circulation and muscle tone[128,130,188]. Some species, such as false killer whales, tolerate this handling well, while others, such as striped dolphins, react violently. Abandon the procedure or use a more gentle approach if the animal resists. After about 15 to 30 minutes of rocking, try again to move the animal into deeper water. Mass-stranded animals should be held in as tight a group as possible; aligning them head to head in a star formation may have a calming effect[193]. (*See also* **7.6.1**.)

Many cetaceans restrand with frustrating persistence—often for reasons unassociated with the initial stranding—each time compounding the damaging effects of the last stranding, until their condition is irreversible. The rescue team should know when to quit and pursue another alternative.

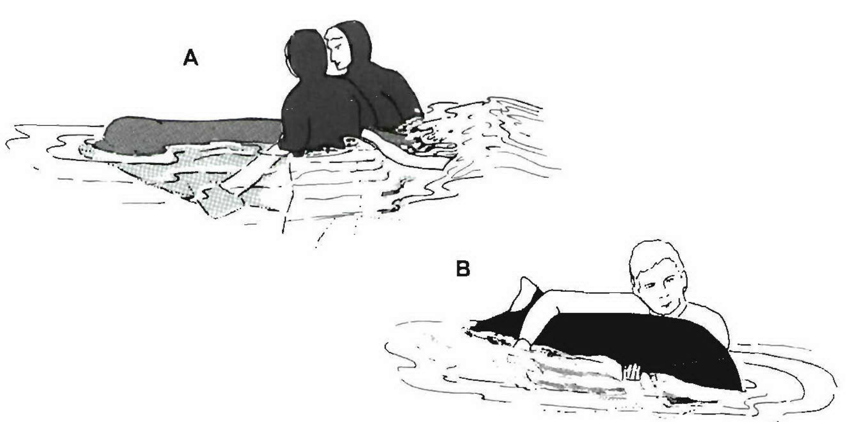


Fig. 6.9. Supporting cetaceans in the water. **A.** Use of strap or sling to keep the blowhole above surface. **B.** Supporting a small porpoise.

6.8.4. Herding and Towing

The cetacean, even when acclimated, may need to be directed outward to sea. In water less than chest deep, this can be achieved by slapping the surface behind the animal. **Avoid swimming close by**: a cetacean's behavior is unpredictable. Kayaks and surfboards are light, portable, and work well in shallow water. "Jet" boats are quiet, maneuverable, have no propellers that might cause injury, and are also suited to inshore work. Once the whale is farther offshore, sturdier craft are needed, manned by at least one observer in addition to the pilot. Boats are generally positioned flanking and to the rear of the whale. Keep the engine speed low and constant (*see also* **7.4.3**). Where conditions (e.g., estuaries or inland waterways) inhibit effective herding, it may be better to secure the animal and tow it to sea.

Towing a cetacean requires skill, experience, and a suitable boat. Improperly placed ropes or slings can cut into the skin or prevent the animal from surfacing to breathe. A whale that suddenly makes a burst for the open sea may swamp a small boat or escape before it can be properly released from its harness. Accounts of restranded animals with rope wounds around necrotic tails are testimony that not all towing attempts are successful. The first rule is to **tow head first**. (Towing backwards by the tail can damage the flukes, dislocate vertebrae, and cause suffocation.) If the animal is strong enough to withstand this treatment, a further danger awaits: when released, it may simply swim straight back to shore[6]. **With all methods of towing, it is certain that a whale, sensing freedom of movement in the water, will decide on its own course.**

For **small cetaceans**, a harness with wide banding and substantial padding will help distribute the pressure caused by towing. For example, a length of cloth or strapping can be draped over the back, and the two ends passed behind and underneath the flippers (one on each side) and attached to the towline. This arrangement tends to lift the animal's head when tension is applied. A similar device with more technical detail[146] (Fig. 6.10) incorporates a broad sheet for maximum distribution of pressure, a swivel to prevent the towline from twisting, and a spring in the towline to minimize speed surges. **All ropes and harnesses must allow for rapid release** when the need arises.

Smaller animals can also be placed in a flooded inflatable raft and towed, or into a specially designed stretcher supported by two rafts or pontoons (*see* Box 6.2), which is then towed as a unit or fastened alongside a boat. Cetaceans can also be "towed" in a stretcher or sling fixed to the side of an adequately large boat (Fig. 6.2). A net sling has the advantages of minimum resistance and easy release.

For **large cetaceans** grounded in shallow water or stranded out of water during low tide, **towing headfirst may be impossible if they are facing the shore**. In such cases, towing tail-first is necessary, but first, the whale must be freed from the suction created by its weight on the beach and made to float in a shallow pool[82].

Bulldozers, backhoes, or high-pressure water hoses—even shovels—can be used to dig a channel to the water and around the animal, or to (carefully!) dig alongside and under the whale until it slips into the excavated channel. In one case, rescuers used a cargo net placed around the head, with nylon ropes running along each side of the body for towing, to successfully pull (tail first) an adult humpback whale from a mud flat in San Francisco Bay[61]. A quick-release fastener can be used to attach the slings or towing bridle to the heavy towline of a vessel waiting offshore. If the animal is floating at all, it will slowly break free when the vessel applies a steady strain on the line; a few tugs may be required[82]. Most line, especially nylon, will stretch enough to prevent snapping when it becomes taut. Once the whale is offshore and facing seaward, the fastener is released and the towing bridle and line retrieved.

Any towline must be sturdy and long enough to keep the whale a safe distance from the propeller. Once clear of the beach, the towline can be shortened to enhance maneuverability in confined waters. A longer line will help keep the animal level and reduce its tendency to rise up and pitch forward into the water. Towing speed should not exceed 1-2 knots[188]. **Monitor the animal carefully while under tow.** It may be necessary to stop intermittently (e.g., 20 seconds moving, 10 seconds stop) to allow the whale to breathe. In general, it is better to keep some tension on the towline to keep the tow manageable and the whale under control. **Make sure everyone is away from the towline when it is brought under tension.**

How far to drive or tow an animal offshore will depend largely on coastal topography. A few kilometers will normally be enough if the beach is open, the coast straight, and the water deep. Strong coastal currents and complex topography may require that the animal be towed a considerable distance offshore before it is released.

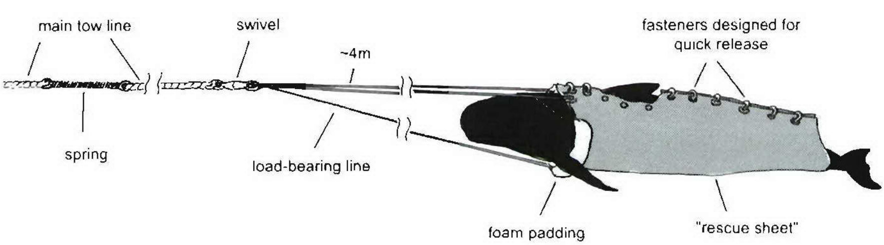


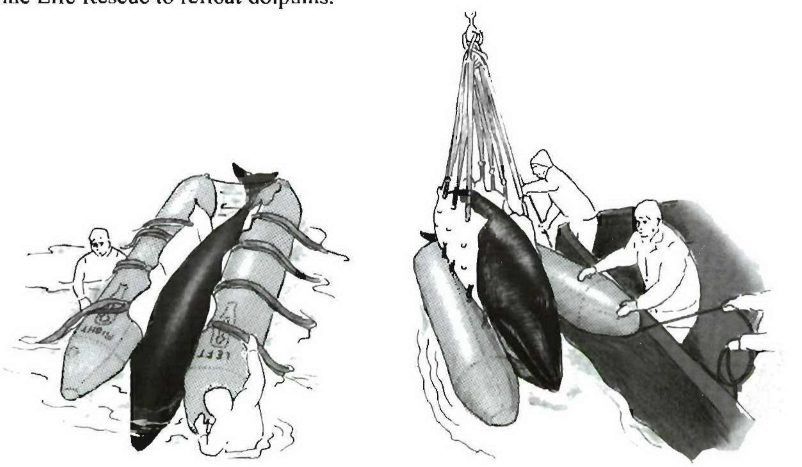
Fig. 6.10. A method for towing utilizing a "rescue sheet" with quick-release fasteners, a swivel between lines from sling and main tow-line to reduce twisting, and a spring in the main tow-line to dampen speed surges.

Box 6.2. Pontoons (*courtesy of* J. Barnett[14])

Pontoons as flotation aids for cetaceans were originally developed in 1985 for use with pilot whales by Project Jonah in New Zealand, where they have since been used to refloat several thousand animals. They are now used in other countries, particularly the UK, and on other species up to the size of minke whales.

Pontoons consist of two 3.5-m-long, inflatable cylinders of heavy-duty PVC, between which a mat is suspended by hooks and rings, arranged so the distance between the pontoons can be varied. Whales are half rolled onto the mat, or it is slid under them, and attached so the animals are high up between the tubes once inflated and afloat. The pontoons are inflated with compressed air from dive cylinders, or manually with a hand pump.

Once afloat on the incoming tide, the pontoon can be guided by hand, or towed attached to the side of a boat (not behind due to the risk of drowning). The whale is released by partially deflating the pontoons. Pontoons are also strong enough to allow supported whales to be lifted onto trucks and boats. Larger whales can be refloated by fastening pontoons together for extra lift. Smaller pontoons have been designed by British Divers Marine Life Rescue to refloat dolphins.



A stretcher attached to pontoons can be used to support cetaceans up to the size of a minke whale and to move them offshore for release.

6.8.5. Helicopters and Boats

Helicopters can be used to move animals off the beach quickly. In one incident, 22 bottlenose dolphins were trapped by a receding tide in a bay on the South Island of New Zealand[28]. A cow and a calf were placed together in a sling, flown offshore, and tethered near a waiting fishing boat. The remaining animals were transported in rapid succession and released near the tethered cow. When the operation was completed, the cow was released, and the entire pod swam calmly into deeper water. Similar attempts to "decoy" a beached pod of pilot whales back to sea resulted in restranding[55].

Small cetaceans can be carried on the decks of fishing boats and released at a suitable site[63]. Such methods have the advantage of moving animals quickly to a specific location—one far enough offshore to discourage restranding. Where the stranding area is inaccessible to land vehicles, helicopters and boats also may be useful for moving animals to alternate holding or release sites, or directly to a rehabilitation facility.

6.8.6. Observing and Monitoring

The success of a release can only be measured by knowing what has happened to the animals, at least in the short term. **One cannot assume that a whale has survived simply because it has not restranded.**

Maintain visual contact as long as possible. Only rarely can an animal be observed from shore. Most serious efforts require sea-going vessels or aerial reconnaissance. Unfortunately, this is expensive and often impossible to arrange. Chemical lights that are visible up to a mile or more away can be used to track released animals at night. These lights come in a variety of colors and can be attached (using biodegradable cotton string) to the dorsal fin tag. Though logistically difficult, radio tagging (satellite, VHF) (*see* **6.8.2, 13.2**) is the only reliable means of determining whether the animal has survived.

6.9. TRANSPORT

The same equipment and approach for moving a whale on the beach is used to load it for transport (Fig. 6.7). The success of the operation often depends on the type of vehicle that can be driven to the scene, although boats and aircraft can be used to take animals to a more accessible site or, in some cases, directly to the care facility. **Do not transport live animals and carcasses together.**

Cetaceans can be transported on stretchers, thick foam pads, or air mattresses. Closed-cell foam is rigid and, because it does not absorb water, remains light; it is ideal for short-term transport. Open-cell foam, preferred for longer travel, is softer and contours easily to the animal's form but will absorb water and become heavy. Animals should benefit by periodically shifting them from one side to the other, although some resist the handling. Specially constructed transport boxes, in which the animal is held upright in a stretcher, are generally used for longer distances. Secure the boxes to prevent shifting and transport the animals facing forward. Drive slowly (<50 km/h) and avoid sudden changes in speed or direction. Use escort vehicles directly in front of and behind open trucks or trucks with flatbed trailers (these are not appropriate for long distances or in cold weather). A police escort is recommended for travel through urban areas, on highways with posted minimum speeds, or in other areas of heavy traffic. Remember to provide enough space for the people and the gear required for the transport.

Protect the animal from sun, wind, and exhaust fumes, and keep it cool and wet. If the transport is to a care facility, one or more representatives from the center should be involved, since they ultimately share responsibility for the animal's health. Attendants should monitor the animal's respiratory rate, record body temperature, and, if possible, collect blood samples (*see* Chap. 10) during transit. This will expedite assessment of the animal's condition upon arrival and allow therapy to begin with minimal delay.

6.10. REHABILITATION

Rehabilitation is often not an option for stranded cetaceans (*see* **4.5**). This may be a matter of policy[130] or logistics: few institutions have the resources to undertake this task.

6.10.1. General Considerations

The care required to rehabilitate a stranded cetacean until it is well enough for release can strain a facility's endurance and budget[4]. An isolation pool with independent filtration is essential to avoid contaminating other animals, and a skilled team is needed for 24-hour care and support. Routine husbandry can be challenging and expensive, as it was for the rescued gray whale calf that ate 350 to 400 kg of squid and fish per day once switched to solid food[25]. The institution bearing these costs may understandably shy away from your plea for help if previous efforts were unsuccessful, as they often are. To keep the doors open, and in the interest of humane care, **select animals for rehabilitation that have a good chance of recovery**, and respect the decision of the accepting facility.

Independent juveniles and young adults of smaller species lifted from the beach soon after stranding are usually good candidates because they can be easily transported and handled for diagnostic and therapeutic procedures. A coastal species such as the bottlenose dolphin has reasonable prospects, whereas stranded *Delphinus*, *Stenella*, and other pelagic forms seem to have more difficulty adjusting to captivity, although some have adapted successfully. A pelagic animal that has come ashore in a mass stranding—which as far as we know is a behavioral and not a health-related phenomenon—or a young dolphin that is merely lost, may have a better chance than a singly stranded animal that is sick and debilitated. **Resist the temptation to bring in orphaned, dependent calves.**

At the center, a new arrival may be placed in shallow water where it is more easily handled for support and medications. In water of any depth, **an animal unable to swim or remain upright will need assistance**. A stretcher fashioned from neoprene (wet suit material) will provide additional buoyancy and protection against heat loss. Certain animals list to one side, either because they are weak, have problems with one lung, prefer to look to the surface with one eye, or simply

because the pool currents force that position. More active animals may require some measures (e.g., attendants placed strategically to guide the animal) to prevent their colliding with the pool walls. A supportive device that allows swimming[90] but prevents contact with walls has the benefit of promoting exercise while minimizing the need for handling.

Cetaceans often fare better in pairs or groups than alone, particularly highly gregarious species such as pilot whales[127]. Due to concerns for disease, however, social groupings are seldom possible unless the animal is part of a multiple stranding or mother-calf pair.

A medical examination should be performed as soon as the animal arrives at the facility so that **therapy**[187] can begin immediately. To **restore salt and water balance** caused by dehydration and shock, the animal can be placed for up to a week or so in brackish water of about 10 ppt—roughly equivalent to the salinity of body fluids—or in fresh water for a few hours at a time, in hopes that it will drink. Replacement fluids can also be given by stomach tube.

After a long time on the beach, larger specimens, such as pilot whales, may suffer poor blood circulation to vital organs including liver and muscle, which then malfunction. Rigorous intervention is required to control and reverse this condition—the early stages of shock. Sometime during the course of rehabilitation, cetaceans are often given **medications for stress**, as well as **antibiotics to control infections** and to prevent pathogens from invading what might now be a weakened subject. Responsible practices call for a judicious approach to treatment based on expert health assessment (e.g., bacterial cultures and antibiotic sensitivity testing).

6.10.2. Nutrition

A **rigorous nutritional program** may be required to restore and maintain the animal's health. First, it may be essential to correct fluid balance by tube-feeding fluids for a few days before giving whole fish or fish gruel. The effort needed for such a feeding schedule is initially demanding, but within a few days most patients will take fish or swallow the feeding tube with minimal help from one or two persons. Although artificial formulas and techniques for hand-rearing calves[173]—even baleen whale calves[25]—have improved significantly over the last decade, raising a calf to weaning is laborious and expensive.

In addition to special nutritional needs, dependent calves require a **social setting** that is difficult and expensive to provide in captivity. Attempts to satisfy this need have included companion animals, such as pinnipeds, and a steady stream of volunteers. A waterbed bladder was used as a surrogate for the mother's body during the rehabilitation of a gray whale calf[25]. Calves are also best provided with a choice of toys, as long as the objects are too large to swallow.

6.11. RELEASE FOLLOWING RECOVERY[162,180] (*see also* **6.8**)

It may be months to a year or more before a cetacean is ready to be returned to sea. In the U.S., criteria for judging suitability for release include satisfactory clinical evaluation, apparently normal swimming and diving behavior, and the ability of the animal to feed on its own—i.e., a good chance for survival. Clinical evaluation should include screening for pathogens of concern (e.g., morbillivirus) to avoid introducing disease into the wild population. Frozen serum from samples collected at admission and again just before release are valuable for future studies on the sources and movements of pathogens. There should be good evidence that a member of a highly social species will be able to interact with others of its kind (*see* Chap. 7). Any human-dependent behavior should be extinguished as part of the approach to preconditioning animals for release.

A young dependent cetacean has a poor chance of survival and still less of being successfully returned to sea. While rearing a calf to the point of physical independence may be feasible[25], **"social maturity" may be equally vital for survival** and perhaps impossible to attain in captivity. The host facility caring for an orphan may have to face accusations that the rescue effort was a veiled attempt to acquire an animal for exhibit.

6.12. EUTHANASIA[76,128,130,134,160]

Saving stranded animals is not always possible. Sooner or later, the response team will find themselves faced with a situation where actions to save the victim are futile and only serve to prolong pain and suffering. **Euthanasia for smaller cetaceans and natural death for large whales may be the most humane and practical option.** Indications that clearly call for euthanasia include:

- disabling injuries (e.g., dislocated or broken tailstock, or penetrating wounds in the thorax or abdomen)
- significant hemorrhage from the mouth, blowhole, genital opening, or anus
- rectal temperature of 42°C or above
- blistering and sloughing of a major portion of the skin surface
- loss of reflexes (e.g., blowhole, palpebral, corneal, genital, and tongue withdrawal)
- loss of jaw tone, or protruding penis.

Euthanizing cetaceans is especially challenging due to their size, physiology, and anatomy. Most methods, even when rapidly effective and considered humane[2], can be visually disturbing and hazardous to bystanders. Use discretion. For the sake of other whales on the beach as well as the public, carry out the procedure behind a visual barrier when methods other than injection are used. When expertise or

proper equipment is unavailable, allowing an animal to die naturally may be more humane than repeated, unsuccessful attempts at euthanasia (*see also* **4.6**). **The choice of method may be limited by agency, network, or local regulations. In any situation, consider human safety first. Note:** suffocation by obstructing the blowhole is neither effective nor humane.

6.12.1. Injection[76,128,134]

In the U.S., injection of an acceptable lethal agent is the preferred and most common means to achieve humane euthanasia in **smaller cetaceans**. In many countries, the use of syringes, needles, and euthanasia solutions is regulated, and **a veterinarian may be required to carry out or supervise the procedure. On the beach, access to and use of solutions must be strictly controlled.** Certain preparations become viscous when cold and require special handling in a winter stranding.

A cetacean up to the size of a pilot whale can be euthanized by injecting a barbiturate or other lethal agent into a vein of the flippers, dorsal fin, flukes, or caudal peduncle, or directly into the heart or abdominal cavity, using an in-dwelling catheter if possible. The dose can be estimated from length measurements. The amount of barbiturate needed can be reduced substantially if the animal is first sedated. Still, more than the calculated amount may be required if the needle is not seated properly in the vein or, for an animal in shock, because circulation to the heart and brain is impaired.

At the point of death or immediately before, the tail may begin to stroke rhythmically in a swimming motion for a few seconds—a behavior known to the old whalers as "flurrying." The action in water may be enough to propel the animal forward, even when held by handlers. The period of flurrying may be reduced or eliminated altogether if enough agent is given quickly, and prolonged if too little is injected or if it is released too slowly. Flurrying—and thus injury to handlers—is less apt to occur if the animal is first sedated. A sedative can be administered using a remote darting system or by intramuscular injection. It is always wise to prepare onlookers for problems that might arise with lethal injections.

An attempt to euthanize a **large whale** by injection into the tail vein or peripheral vessels is likely to be unsuccessful as well as prohibitively expensive. On one occasion, experienced personnel[126] used 1,500 mL of solution (worth $1,200) before abandoning the approach. The animal, a 20-ton fin whale, was later euthanized quickly by an injection directly into the heart. This was accomplished using a "needle" fashioned from 1 m of stainless steel automobile brake line (available from auto supply stores in diameters ranging from 3/16" to 5/16"). The line was sharpened to a beveled point on one end, attached by means of a rubber sleeve to a large syringe on the other, and fitted inside with a plug (trocar).

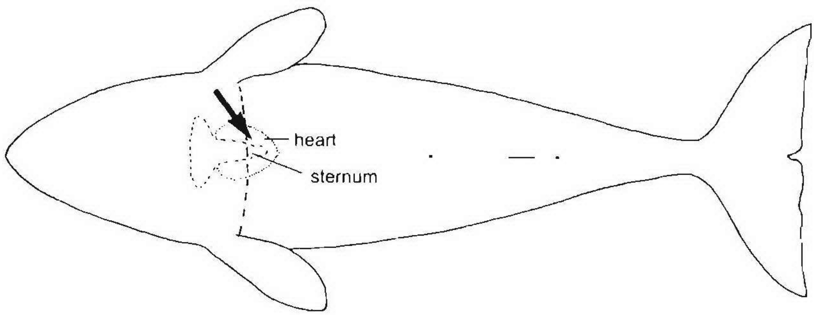


Fig. 6.11. The base of the cetacean heart can be reached from either side of the sternum along a line connecting the base of the flippers.

Subsequent observations suggested using a needle equal in length to about 1/2 the diameter of the whale, inserted through an incision (made following local anesthesia) penetrating the skin and blubber.

As a rule of thumb, **the heart can be reached by directing the needle from a point just behind the origin of the flipper to the same point on the opposite side of the body**. The heart can also be reached by inserting the needle to either side of the sternum at a point just posterior to a line joining the base of the flippers (Fig. 6.11). The quantity of solution required will depend on its type and strength and on the condition of the animal but will be much less than if administered into peripheral vessels. **Carcasses that may contain a high concentration of barbiturates or other lethal chemicals should be disposed of in a manner that will minimize the risk to scavengers** (*see* Chap. 11).

6.12.2. Shooting[130,188]

Dolphins and small whales (to 8 m) can be killed quickly by shooting. Any high-powered rifle with standard bullets can be used for cetaceans less than 2 m. For cetaceans 2 to 8 m in length, use a firearm with a large bore (.303 or greater) and high muzzle velocity, and 180-grain soft or solid round-nosed bullets. The gun should be fired approximately 1 meter from the animal's head; a firearm discharged directly against the skin may explode. Aiming down and backward through the blowhole to an imaginary point joining the flippers is sometimes recommended[160]; however, if the shot is aimed too far backwards, the bullet must pass through the thickest part of the skull. Alternatively, shoot from the side, about halfway between the posterior margin of the eye and a point above the origin of the pectoral flipper; for added assurance, fire three shots in a line through the targeted area (Fig. 6.12). Even in a small animal, **the site for bullet entry is critical**.

Shooting is generally not advised for euthanizing whales more than about 8 m in length or sperm whales of any size (due to their cranial anatomy). However, in New Zealand, where cetacean strandings are common, shooting is the only permitted means of euthanasia and is undertaken only by trained officers who follow established procedures. Baleen whales 8 m and above are shot in the brain, about 55 to 75 cm behind the blowhole (depending on the size of the whale), using a large-bore firearm (.303 or greater) with Mk.6 or solid, round-nosed projectiles. A specialized firearm (Sperm Whale Euthanasia Device [SWED]) is used on stranded sperm whales. When use of firearms is considered unsafe, the animals are allowed to die naturally.

Shooting may be inadvisable in areas where rocks increase the danger of ricochet. In any case, make sure that members of the public and all non-essential personnel are well away from the area.

6.12.3. Explosives

When shooting is not an option and euthanasia solutions or persons qualified to use them are unavailable, other methods can be employed, providing implementation is relatively painless and death is rapid. Explosives have been used to humanely euthanize large whales, although **the procedure must be supervised by an expert and may require special arrangement with local and regulatory authorities**. When placed either deep in the whale's mouth[28,128] or on the cranium or nape and covered with sandbags and heavy rubber[19,62], explosion can cause immediate death without excessive noise or mess. Whaling industry research suggests that a penthrite (30 g) grenade shot from a harpoon gun into the thorax

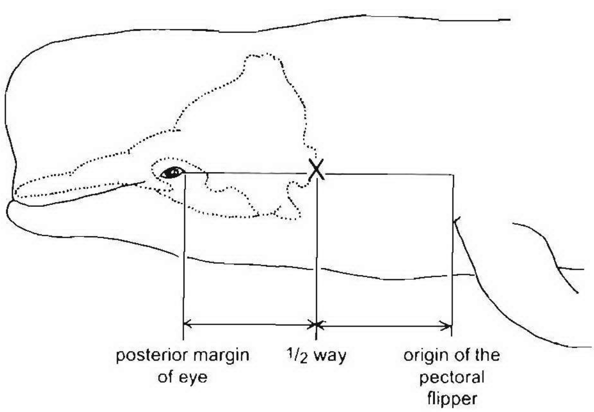


Fig. 6.12. Target area for euthanizing odontocetes by shooting. The target area X (occipital condyles) is reached by a shot fired from above or below, or from the side halfway between the eye and the origin of the pectoral flipper. (From New Zealand Department of Conservation[130].)

or cervical spine region causes immediate loss of consciousness and rapid death due to pressure-induced trauma to the brain[97]. **Any method involving explosives is dangerous if not done properly, may be prohibited, and is likely to be met with resistance if attempted on a public beach.** Take strict precautions to keep everyone at a safe distance.

6.12.4. Exsanguination (Bleeding)

Exsanguination, while controversial, may be an option when other methods are unavailable or unsafe. The technique requires expertise, is bound to generate adverse public reaction, and is considered humane only when carried out on a heavily sedated or unconscious animal[2]. The technique requires thorough anatomical knowledge of the head and cervical spine, or the location and approaches to the heart. It should not be carried out on a whale that is alert and responsive and may not be necessary on one that is in shock or unconscious. Add to that the reaction of bystanders and it is likely that this procedure will drop to the bottom of your options list.

6.12.5. Confirming Unconsciousness and Death

For large whales in particular, confirming unconsciousness and death can be difficult. The following practical approach has been developed using captive cetaceans[96]:

1. Are there signs of motor activity? If yes, assume the animal is conscious (continue to 2).
2. Are any reflex responses positive (e.g., pupillary reflex, palpebral reflex, threat response, or corneal reflex)? Is there jaw tone? If yes, assume the animal is conscious (continue to 3).
3. Does the animal have a detectable heart beat, capillary refill time <3 seconds, or an ocular/skin temperature difference >4°C? If yes, it is probably alive. If no, it's probably dead.

Animals positive for any test are assumed to be conscious or alive, as appropriate, and those that show signs of consciousness must be considered capable of suffering[96].

Chapter 7
Cetaceans - Mass Strandings

We define a mass stranding as two or more cetaceans (excluding cow-calf pairs) of the same species coming ashore at the same time and place. In North America, only a few species of odontocetes typically mass strand in groups of 15 or more: sperm whales, pilot whales, false killer whales, Atlantic white-sided dolphins, white-beaked dolphins, and rough-toothed dolphins. Several other species occasionally come ashore in smaller numbers (e.g., pygmy killer whales, common dolphins, *Stenella* spp. and Fraser's dolphins) (*see* **15.2**). All are gregarious, more or less pelagic forms, or at least less accustomed to inshore waters than such coastal dwellers as bottlenose dolphins or harbor porpoises.

7.1. WHAT IS THE ATTRACTION TO SHORE?

Various theories have been proposed over the years to explain mass strandings, some more credible than others. That certain species of cetaceans would attempt to follow ancestral migratory routes or, in times of stress, seek safety on land[93] is difficult to believe, and harder to prove. The concept of mass strandings as a means for population regulation of social species with low juvenile mortality rates and long life spans[71] also seems improbable: other density-dependent mechanisms (e.g., changes in birth rates or fertility[17,44]) likely play a greater role in population control than strandings, which involve a relatively small number of animals.

Certain pelagic species **follow their prey inshore**. Atlantic white-sided dolphins do this regularly in the Bay of Fundy, and long-finned pilot whales seeking squid and herring venture closer to Cape Cod (Massachusetts) as winter approaches. The activity is usually uneventful, but occasionally a group strikes land. From 1981 to 1991 there were at least 10 separate mass strandings of pilot whales within about a 20-mile radius on Cape Cod, totaling more than 475 animals, between the months of September and December. That appears to have been a peak decade for pilot

whale fall and winter strandings: only one winter incident had been recorded from that area in the previous 20 years, and only two others, involving 22 animals, from 1992 through 2002[78,90].

There are too few data to demonstrate any cyclic activity in stranding patterns. Some investigators have correlated stranding frequency with periods of climatic warming and oceanic current changes that shift the abundance or distribution of prey[56,72,73,83]. Perhaps such events bring more animals closer to shore, thereby increasing the likelihood that some will come aground.

While pelagic cetaceans do follow prey inshore, there is often no evidence that they were feeding at, or just prior to, the time of stranding[19,49,68]. Apart from bringing whales and dolphins into risky territory, it is doubtful that inshore foraging behavior alone plays a major role in these events, although even coastal species are sometimes caught by an outgoing tide. Beluga whales feeding during the salmon runs in Cook Inlet, Alaska, for example, occasionally strand in large numbers during unusually low tides; most appear to suffer little harm from the temporary grounding and resume activities when the water returns[4].

Klinowska[37,38,39] proposed that cetaceans use the earth's **magnetic field** as both a compass, as do some other vertebrates[27], and as a map for navigation. This hypothesis stemmed from a historical review showing that strandings on the British coast tend to occur where the north-south magnetic contours of the ocean floor intersect land perpendicularly (especially in areas of geomagnetic lows or "valleys"), suggesting that the animals might have misinterpreted geomagnetic information. Attempts to link strandings to geomagnetic topography in other areas have met with mixed results, e.g., correlations have been reported for some parts of the U.S. Atlantic coast[36] and Hawaii[45] but not in New Zealand[7,10].

Some species of cetaceans apparently have, in the soft tissue covering the brain, single-domain magnetite crystals[5,89] of the type found in other vertebrates that use the magnetic field for orientation[35]. It remains to be seen whether these simple particles can allow a cetacean to determine north and south, and more importantly, its actual position. The latter, a "magnetic map sense," has not been proven for any species of animal[27]. Limited experimental efforts to demonstrate cetacean sensitivity to magnetic fields, involving a few captive bottlenose dolphins, have yielded contradictory results[5,40]. Further research may establish whether cetaceans utilize geomagnetic information, which might bring them inadvertently to certain inshore locations. The results are less likely to explain why they strand.

Mass strandings occasionally coincide with **unusual environmental conditions**, both natural and human-related. Severe hurricanes may have led to the stranding of five pygmy killer whales in the British Virgin Islands in September 1995—only the second such event recorded in the Caribbean[50]—as well as the rare stranding of

four Gervais' beaked whales in North Carolina in 1998[57]. Intense sound pressures associated with military sonar or underwater explosions (*see* **6.2.2** and Box 10.4) have been implicated in several mass and mixed-species strandings[32,74,82,84]. It is reasonable to expect that natural underwater phenomena, such as seaquakes, might have a similar impact. Whether some events represent a true mass stranding or the coincidental stranding of individual animals affected by the same unusual conditions or phenomenon (i.e., multiple strandings or die-offs [*see* **1.2**]) may be difficult or impossible to determine.

7.2. IN THE SURF ZONE

Many species of cetaceans come close to shore, but few strand. The reason for their presence in shallow water seems less important than the possible factors that occasionally result in large numbers coming ashore.

In some cases, animals are **trapped and grounded** by the outgoing tide. A fortunate few, maybe some with experience, refloat themselves and swim away on the following tide[4,23,48], while others become stuck[23]. Such accidents typically occur in areas with long meandering channels, broad tidal flats, strong or unusual currents, or extreme tidal flow or volume[55,92], sometimes in conjunction with spring tides near full or new moon[10,47]. There are several such "whale traps" in North America, including Sable Island (Nova Scotia)[20,43], Lingley Cove (Maine)[19], Wellfleet Bay (Cape Cod, Massachusetts)[92], Cook Inlet (Alaska)[4], and parts of the Gulf of California[24]. Major mass stranding sites in New Zealand share similar coastal topography, i.e., gently sloping, sandy beaches with an adjacent protruding section of coastline[6]. In the southern North Sea, the intricate configuration of shallow water, sandbanks, mudflats, islands, and estuaries may serve as a trap for sperm whales that accidentally stray into the area[30].

The way a species behaves in **panic** might influence its chances of stranding[25]. Humpback and gray whales reportedly change direction repeatedly during flight[77], and whether that is related or not, seldom mass strand. In contrast, a frightened sperm whale may steer a straight course for hours[70], even ramming objects in its path[77] without changing direction. They do mass strand. Coastal whalers use sharp sounds to drive striped dolphins and pilot whales ashore, banking on their tendency to flee in a straight line from the source of alarm[51,72]. This type of response might direct pelagic animals away from danger in open water but, when inshore, cause them to strand on any beach in their way. To complicate matters, some species prone to panic, including pilot whales and sperm whales, sometimes swim calmly to shore with no apparent sign of alarm[15,16,60].

Shortly after the discovery that some odontocetes use echolocation to perceive their environment[34,46], Dudok Van Heel[12,13] proposed that **distortion of echolocation signals** in shallow water may provide an animal with false clues, causing

it to beach. The problem would be greatest in areas of gently sloping beaches, a feature common to many (but certainly not all[19,37]) mass strandings, and during storms when water is churned with air and sand. Echolocation failure has since been linked to other suggested causes of mass strandings: environmental factors such as thermal gradients[58,64] and complex topography[47]; illnesses such as parasitic neurologic disease[52,65]; and, more recently, noise-induced trauma to the inner ear[82].

Echolocation failure as a cause of stranding of healthy animals presumes that these species rely almost exclusively on echolocation when in near-shore waters and that this faculty becomes seriously unreliable under certain conditions. It also assumes that the echolocation of pelagic forms is less sophisticated than that of *Tursiops*, a species that seldom mass strands (in the strict sense of the definition), and the one from which we have largely modeled our understanding of cetacean echolocation[33,89]. Yet experiments with false killer whales indicate an acoustic sense comparable to that of some inshore species and the capacity to alter signals to compensate for background noise[76]—in other words, some capacity to adapt to unusual conditions. The ability of pelagic forms to navigate inshore is not entirely deficient, since we know they enter shallow waters far more often than they strand.

To what extent does noise in the surf zone limit the ability of a sonar-equipped cetacean to accurately perceive its environment? What happens to a whale whose hearing is impaired by neurologic disease[9,28], parasites[11,22], or trauma[3,82]? Would a whale in trouble use echolocation to the exclusion of other senses? Cetaceans have good underwater and aerial vision[89] and would also be expected to employ passive listening[62] to gain environmental cues. When information received from one sense is confusing or conflicts with that received by another, would they not employ an alternate strategy? These are fascinating topics for research that must be squarely addressed before flawed echolocation alone can be accepted as a basis for strandings. However, it is reasonable to assume that a pelagic cetacean in severe pain or distress might be less able to compensate for the loss of a primary navigational sense.

Some studies have shown that individuals within a mass-stranded group bear evidence of **current illness**[14,86,87]. Others show effects of **long-standing disease**, which in some cases may have debilitating effects[23,68]. Could disease in one or more individuals cause the group to wander beyond its "safe" range or encourage the initial stranding? Confounding the issue, however, is that chronic diseases are commonly found in outwardly healthy free-ranging cetaceans, both those that mass strand and those that do not[41,85].

In any case, **mass strandings, particularly in areas where such events are common (e.g., "whale traps"), can be reasonably presumed to include many healthy individuals, although some members of the group may be ill**[92].

7.3. COMMON ELEMENTS

Cetaceans that mass strand are generally pelagic forms with a highly evolved social structure. Certain aspects of behavior that benefit the school in open water seem sometimes deleterious near shore. Norris and Dohl[59] explained that for these species, "*the school represents the focus of all living activity, and lone animals at sea tend to be severely frightened...once a large number of a group project common signals about the direction of movement, the factors which determine school structure act to insure its unified application.*"

In other words, **once a critical number of animals heads for shore, the rest of the herd is likely to follow**. What is the initial stimulus? Observations suggest there may be many situations, such as simple grounding, illness in an individual[63,68], and electrical storms and other meteorological events[67,77], in which animals are drawn to assist one another[42,63] or perhaps led to panic[25,67].

Social organization alone, however, does not provide all the answers. For example, some strandings are spread over miles of coastline, or occur over a period of days or longer[1,16,26,92]. Only part of a pod may strand while the rest of the animals leave or do not become involved[2,47]. Many species that form large schools, such as spinner dolphins and Pacific white-sided dolphins, seldom mass strand. Clearly, other factors contribute to strandings[21], but social cohesion is a common thread running through other sometimes nebulous and often untestable theories.

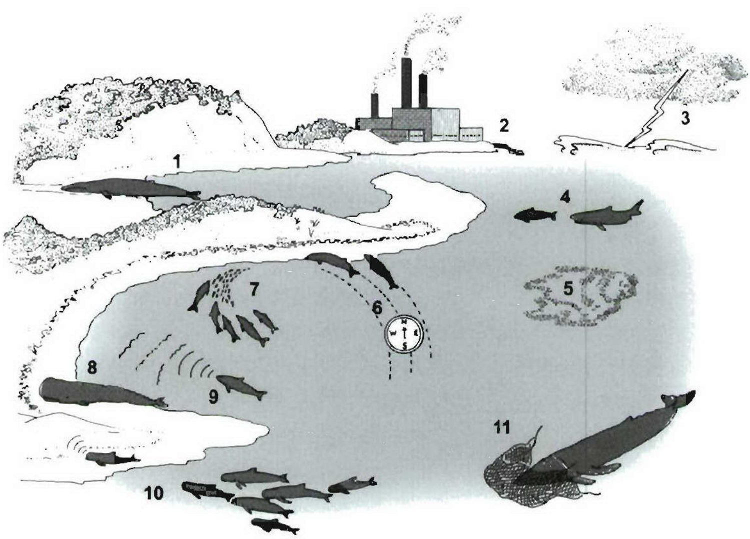


Fig. 7.1. Possible causes of cetacean strandings. **1.** Complex topographic and oceanographic conditions. **2.** Contaminants. **3.** Weather conditions. **4.** Predators. **5.** Natural toxins. **6.** Geomagnetic disturbances and errors in navigation while following geomagnetic contours. **7.** Following prey inshore. **8.** Disease. **9.** Disturbance of echolocation in shallow water. **10.** Social cohesion. **11.** Human-related injuries.

At some point certain strandings seem to be ordained and the animals determined to remain ashore, returning each time they are pushed out to sea[8,16,60]. Refloating the majority of the group may be successful, some suggest, when a vocalizing animal is first returned as a decoy to deeper water[10,16,61,66]. However, rescue is not always that simple. Animals may still attempt to rejoin any herd members still on shore. Others, pushed or released offshore, may panic and flee in a straight line, back to the original stranding site or to another nearby beach.

The initial stranding can also result in physical damage and **physiological stress and shock** (*see* **6.6.2**), conditions that further impair the animal's chances for survival[18,69,81]. When released, stranded animals sometimes return, not necessarily because they are compelled to be there, but because one or more of them are now overcome with illness acquired during the last stranding. Even temporary muscle stiffness resulting from grounding can cause animals released without sufficient acclimation time (*see* **6.8.3**) to swim in a curved path that can bring them back to the beach[91]. For others, the damage may be far more severe. In other words, subsequent attempts to strand may have little to do with the reason the animal or group came ashore in the first place. **Understanding the debilitating effects of stranding, particularly for those animals that restrand, is vital to planning an effective response with realistic goals.**

7.4. STRANDING RESPONSE

Information on cetacean biology and natural history, stranding patterns, basic equipment for handling, supportive care, rehabilitation, and euthanasia is presented in Chapter 6. Much of it applies here, but a mass stranding requires a particular approach tailored to the size and number of animals, time ashore, and, of course, the available resources. Small details on location, weather conditions, orientation of the carcasses—of little value in single strandings or die-offs—suddenly become important resources for later attempts to determine the cause of the event (*see* Box 10.1, Level B data). See Chapter 2 for information on basic organization and training. In areas where mass strandings are common, consider developing response protocols consistent with the U.S. Incident Command System to allow improved coordination among various agencies that might be involved in these efforts (*see* **2.4.2**). This approach has been implemented fully in New Zealand[54] and is being put into practice in the U.S.[79]. The following sections discuss specific needs and actions when responding to a mass stranding.

7.4.1. Organization

One person must be in charge of on-site activities (*see also* **2.4**, **2.6**). This stranding (or site or event) coordinator can then delegate to several assistants the responsibilities for various aspects of the operation. These may include:

- Coordinating with local authorities, the public, and media
- Assessing environmental conditions and logistics
- Procuring supplies and equipment, and tracking costs
- Training and supervising on-site volunteers
- Providing personal amenities for all workers
- Looking after the health and safety of the team
- Supervising animal support, handling, and transport teams
- Examining carcasses and collecting tissues
- Assembling completed data forms and collected samples
- Disposing of carcasses
- Debriefing all involved personnel.

Individuals must remain focused on their assigned tasks. Volunteers recruited on-site can be an essential resource and only too willing to help, particularly during rescue operations. Their work, involving little risk, must be fully supervised (*see* **3.2**, **12.3**). Waterproof cards that outline key tasks, roles, and safety information can serve as handy reminders for on-site volunteers, as well as for coordinators, team members, and other responders.

7.4.2. Early Warnings

Mass strandings may be foreshadowed by **unusual behavior** of animals still in the water[2,15,31,66]. For example, pelagic species appearing uncharacteristically near shore or remaining in inshore waters may be candidates for eventual stranding. The pod may be **"milling"**—continually circling or moving haphazardly in a tightly packed group—with a member occasionally breaking away and swimming toward the beach. Such behavior may last for only a few minutes or for several days but is often a precursor to stranding. Early reporting will allow the Operations Center to respond promptly, with greater chance of either preventing the stranding or rescuing those animals that come ashore.

7.4.3. Averting a Stranding

The health condition of animals in a mass stranding is generally unknown at the outset. While averting a stranding might only prolong the suffering of seriously ill animals, the welfare of others—as well as public opinion—may demand intervention.

When a stranding appears likely, measures may be taken to drive or herd the animals into deeper water or away from immediate danger (*see also* **6.4.2**). Take advantage of the same social instincts that formed the group in the first place. In deeper water, use boats (perhaps in conjunction with lines with weighted "stringers" designed to be towed between two boats) to herd the animals offshore[80]. Slowly sweep back and forth, staying a safe distance behind the animals when the boat is in gear. Avoid sudden changes in speed or direction. If this fails, acoustic deterrent devices (i.e., pingers)—placed at least 30 m behind the animals if possible—may be helpful when used in conjunction with small boats[79,80]. Move slowly, letting the animals move away from the pingers toward the open water. With any method, do not block the route of escape, and discontinue efforts (or pause) if signs of increasing stress (e.g., erratic movements, tail slapping, etc.) last for more than about 15 minutes.

Once animals are in the shallows, some may still be herded away from shore using boats, noise, and people in the water. When this is no longer practical, handling is necessary. Align one or more animals in deeper water facing seaward for others to follow, or hold or tether one or more offshore as a decoy[10,16,61,66].

Choosing a decoy is not easy. The "herd leader" might be the ideal candidate, but only the other members of the group know which one that is, and if they followed it to shore once, they may do so again. The animal chosen should be healthy (a sick one may also bring the pod back), alert, some suggest vocal, and able to withstand towing or other procedures. Although an adult might seem appropriate[16], a juvenile may, in fact, elicit a greater response from other pod members.

Position the decoy so it vocalizes toward the herd (hopefully beckoning and not discouraging them), and release the decoy once the group ventures into deeper water. **Every animal handled should be identified with a tag** (*see* **6.8.2** and **13.2**), and the details (tag number, time, location) reported to the Operations Center.

In some cases, euthanizing the first animals that strand may be necessary to prevent their vocalizations from drawing the rest of the herd ashore. Removing carcasses from the water (as feasible) may help discourage additional strandings and will provide safer working conditions for the team.

7.5. FIRST AID

7.5.1. Determining Condition

At a mass stranding, **always deal with live animals first**. Decide quickly whether further strandings can be averted, and determine which animals should be rescued, euthanized, or prepared for transport to a care facility (*see* Chap. 6). A well-trained team can evaluate a large number of carcasses quickly. An organized, objective approach, perhaps using readily interpreted evaluation forms (e.g., Table 7.1), may increase efficiency[91], keeping in mind that nothing can replace experience. Besides individual animal health, other factors—environmental conditions and the time and resources available (*see* **4.3**)—will influence how many animals might be saved.

Identify each animal, including carcasses, with a field number and with non-adhesive, highly visible, colored ribbon, or a cattle ear tag to direct the teams responsible for treatment and handling (*see* Chap. 6), sampling (*see* Chap. 10), and disposal (*see* Chap. 11). A prominent, spray-painted "X" will make carcasses easily distinguishable. **Make sure that carcasses are marked or tagged with clearly visible field numbers before they are photographed or removed for necropsy.**

When live and dead animals are crowded in the shallows or on the beach, carcasses may have to be moved or removed to clear room for the rescuers to work. Organize a team of "specialist haulers and righters"[75]—strong people responsible for moving carcasses and rolling live animals upright. A team of about 8 strong people can quickly shift carcasses (up to the size of a pilot whale) by hauling on a rope secured around the tailstock.

7.5.2. Handling and Supportive Care

All live animals should be given supportive care. Organize enough working groups, each with an experienced team leader, to ensure safe and appropriate handling of each animal (*see* **6.6**, **6.7**, **6.8**) without squandering resources. Appoint a roving technical advisor to relay instructions to all groups and offer guidance. Keep the team's safety in mind; allow only those with suitable apparel and equipment (e.g., wet suits) to work in harsh surf or weather conditions (*see* **12.2**, **12.3**).

Each group should be large enough to tend to an individual animal's needs. When fewer persons are available, **invest in animals judged to have the greatest prospect for survival**, not those near death, and stick to the basics. Protect against sunburn, gently douse with water, and monitor respiratory rates and behavior as a head start for the handling team when it arrives. Avoid the urge to do much more. Moving any cetacean requires force. Up to 10 or more people may be needed to carry a young pilot whale; three times that number will be unable to lift an adult.

Table 7.1. Sample Qualitative Evaluation Sheet for Mass-Stranded Cetaceans[90]

Category	ID#1	ID#2	ID#3	ID#4	ID#5
Length	+	+	+	+	Dependent calf
Body Condition	+	-	+	-	+
Eye Blink Reaction	-	+	-	-	+
Flipper Reaction	+	+	-	-	+
Ventilation Quality	+	+	-	-	+
Mouth Reaction	+	+	-	-	+
Mouth Lining Color	+	+	-	-	+
Gum Color	+	+	-	-	+
Capillary Refill	+	+	-	-	+
Attitude	+	0	-	-	+
ACTION	Immediate Release	Rehab/ Euthanasia	Euthanasia/ Rehab	Immediate Euthanasia	Rehab/ Euthanasia

Criteria (*below*): + = favorable response; - = unfavorable response; 0 = inconclusive. **Reminder: Nothing takes the place of experience.**

Animal length: may identify dependent young (degree of tooth eruption may be better indicator) and those too large for easy transport.

Body condition: e.g., emaciation (evident as concavity in back/neck area), serious wounds or lesions, etc.; **may override other criteria**.

Eye response: + tapping near the corner of the eye causes animal to blink; - no blink is elicited.

Flipper response: + flipper returns quickly when moved slightly from original position; 0 returns slowly; - does not return.

Ventilation quality: + blowhole seals tightly between exhalations; - gas escapes between exhalations.

Mouth response: + attempt to open mouth meets moderate resistance; - mouth cannot be opened or is easily opened and the animal reacts with exaggerated response.

Mouth lining and tongue: + pink; - gray; 0 mouth cannot be opened.

Gum color: + pink; - gray.

Capillary refill: + pressure on gum causes color change that rapidly returns to normal ($\leq$ 2 seconds); 0 color returns slowly; - gum is gray or stays gray.

Attitude: observer's impressions, e.g., + for "feisty", - for unresponsive.

Comments: additional relevant factors, e.g., duration of stranding, relative time of stranding (e.g., early in event may signify poor condition), and logistics **may override all other criteria**.

Action: most categories +: candidate for immediate release. Most categories - (or body condition and logistics -): immediate euthanasia. Some non-releasable animals may be candidates for rehabilitation.

7.6. OPTIONS

7.6.1. Immediate Release

The goal should be the swift release of the largest manageable number of animals that have the best chance of surviving. Carefully select candidates for release, and resist the pressure to "let them all go." As social animals, **the integrity of the group may be as important to survival as the health of the individual.** Without information on what constitutes the minimum size or critical composition of a viable pod of whales, an arbitrary decision will have to be made when assembling a group for release. If a highly infectious disease is suspected (e.g., morbilliviral disease), release may not be appropriate for any members of the group.

Animals that strand later in an event are generally better candidates for release than those that strand early, not only because of the shorter time on the beach, but also because those that leave socially cohesive groups and come ashore when deep water is still available are probably debilitated[91]. In shallow areas, larger animals will be the first to strand as water depth decreases.

Provided the site is appropriate for release, animals in good condition closest to the waterline should be the first returned. Begin by holding them, together with any unbeached animals, in shallow water as a nucleus for rescue. Give healthy, strong animals priority. **Mothers and calves should be moved together.** A mother whose calf is dead may be less prone to restrand if the calf is refloated with her and kept from shore. Animals further up the beach will have to wait for sufficient resources to move them to the water—or may be candidates for euthanasia—but until the decision is made, must receive supportive care (*see* **6.6**). **Attempts to release individuals or small groups while the main group is still onshore are likely to fail.**

A proven approach is to relocate as many animals as possible to a safe place in shallow water where they can rest and become reoriented[18,61,88,92]. When the stranding location is inappropriate for safe release, for example, due to shallow water or the potential for restranding, the holding/release site may be 40 km or further away[18,92]. There, assigned team members can tag each animal, monitor behavior and vital signs, and obtain blood samples so that useful correlations can be made for any individual that restrands. This strategy permits the team to work as a unit instead of dealing with animals independently and haphazardly. It also allows the entire pod to be freed together, into a clear path to open water, and when surf and tidal conditions are appropriate, thereby minimizing the likelihood of restranding (*see also* **6.8**).

Depending on resources, a group of animals might be transported offshore by boat or helicopter to draw other members of the herd away from the beach (*see* **6.8.5**). Regardless of the strategy, **ensure sufficient acclimation time in the water prior to release**, particularly for animals that have been lying on their sides (*see* **6.8.3**).

7.6.2. Transport to Care Facility

Animals that require medical care may be transported to rehabilitation facilities (*see* **6.9**, **6.10**). Make a point of selecting two or more individuals for each center. A cetacean recovering from a mass stranding will undoubtedly benefit by socializing with others of the same species, and successful release virtually depends on it[53].

Recognize that **few facilities can afford this option, have the necessary quarantine space, or are willing to risk the introduction of harmful pathogens to animals in their permanent colony**. Be realistic. The chances for survival of two or more animals from the same group are low and—except for highly endangered species—the conservation value of releasing even a few individuals is negligible. Unless there is real opportunity for valuable research (e.g., health studies or post-release monitoring[53]), consider other options.

7.6.3. Euthanasia

Euthanasia (*see* **6.12**), besides its humane purpose, may be the only recourse to prevent hopelessly stranded animals from drawing others to shore. Thus, the survival of the group may rest on the lives of a few. Rescuers are on trial each time they confront a whale that is healthy, but cannot be rescued, and whose condition will inevitably deteriorate. Take the time, basing the decision on logistic considerations and careful examination, including blood samples if possible; explain your reasoning and proceed with confidence. **Make sure the team has realistic expectations.** Despite intervention, most or all of the animals in a mass-stranded group may die. **At some point in the rescue process, euthanasia may be the most humane option.**

The time and method of euthanasia should be noted on the data sheet and on the identification tag to assist other teams that will require this information.

7.7. ORGANIZING TO COLLECT SPECIMENS AND DATA

Data and specimens collected from fresh carcasses are essential for a successful investigation (*see* Chap. 10). Yet the stranding investigator who ignores the needs of live animals for the sake of "science" will understandably anger team members and spectators alike. One approach is to quickly remove some of the freshest carcasses to a location suitable for necropsy, while maintaining efforts on the beach to help those that are still alive. Ideally, some carcasses can be transported to

a well-equipped facility and examined by specialists, and samples collected under optimum conditions. Generally, however, most data and samples are collected in the field, under far less than ideal circumstances.

Valuable time can be lost wandering among carcasses, puzzling over what to do and whether it has already been done. **Examining large numbers of cetaceans requires working teams, each performing a specific task on all carcasses.** Be realistic about the size of the job—it can be big.

At least three teams are needed:

1. Measuring group	2 persons to obtain morphometrics
	1 person to record data
2. Sample collection	1-2 persons with basic anatomical knowledge to collect specimens
	1 person to label and bag samples
3. Necropsy team	1 skilled "pathologist"
	1 assistant
	1 person to record data

Each group conducts its activity in pre-arranged order, marks the carcass (alphabetic, numeric, or color code) to show its work is completed, and moves on to the next. Specimens for contaminant analyses and microbiology are best taken from fresh carcasses; this requires close cooperation between the sampling and necropsy teams (*see* **10.9**, **10.10**). **Any priorities for specimen collection must**

be determined beforehand and clearly communicated to the sampling team. The disposal group removes only the carcasses that are marked to show all other tasks have been completed. This approach allows the on-site coordinators to assess progress at a glance and make adjustments in task assignments to balance activities as necessary.

The teams' progress depends on a steady supply of equipment and data sheets. Pre-packaged measurement, dissection, and sampling kits (*see* **2.5.2** and Box 2.1) will save time at the outset and will need to be replenished as materials are misplaced, broken, or depleted. Individuals should be assigned the task of collecting completed data sheets and placing them into a (supervised) central file.

Pay attention to hygiene, and provide personal amenities for the team (*see* **2.6.3**). Require everyone to wear gloves, and have face protection available for those conducting necropsies. Arrange for a steady supply of clean water for washing hands and equipment. Have the necessary materials and equipment to clean and sterilize instruments when collecting specimens for microbiology and toxicology (*see* **10.9**, **10.10**).

All collected samples and data (clearly labeled with the proper field number) must be retrieved, organized, and centrally stored at the end of each day, under the supervision of a designated person. Specimens for shipping must be properly packaged and documented (*see* **10.14**).

Emphasize quality (*see* 10.1). It is better to obtain good samples and perform thorough examinations with accurate documentation on a small number of animals than to do a hasty job on many.

Behavioral and environmental data (*see* Box 10.1 Level B Data) **are critical** for determining the cause of a mass stranding and may influence response options. Behavioral observations collected before and during the event can provide important clues regarding social bonds, or identify the first animals ashore—perhaps candidates for immediate euthanasia. Aerial surveys can yield essential data for larger or prolonged events. Unusual weather or oceanographic conditions (e.g., an unusually low tide) might suggest the accidental stranding of otherwise healthy animals, which, if released quickly, could have a good chance of survival. Conversely, a prolonged stranding over many days under calm conditions suggests debilitation or disease—factors that would argue against immediate release and underscore the need for comprehensive health studies. Current or recent unusual environmental conditions (e.g., a toxic algal bloom or severe storms) might suggest that the stranding is part of a larger event, requiring a broader investigation and a different approach (*see* **2.7**).

7.8. MONITORING FOR RESTRANDING

Rapid response by a trained team can result in the successful rescue of many members of a mass-stranded group[92]. However, some of those returned to sea may restrand, sometimes immediately but perhaps days or even weeks later[29,49,60]. The success rate of most rescue operations is largely unknown and can only be determined by long-term monitoring of animals that are tagged and released (*see* **6.8.2**, **13.2**). The cost of surveillance can be cut and the effectiveness increased if local individuals or groups (e.g., fishermen, Coast Guard, sailing clubs) are included in the effort. Combined with the attention of the media (now certain to be involved), this broadened array of observers will increase the likelihood that sightings or strandings will be reported in time to take action.

7.9. CONTINGENCY PLANS

When feasible, **develop site-specific plans in areas where mass strandings are common**. For example, one area of Wellfleet Bay, Cape Cod, is a known natural trap for cetaceans. Animals gather in deeper water as the water recedes but are eventually grounded at low tide over miles of inaccessible mud flats. A local stranding network implements a proactive strategy focused on averting a stranding when cetaceans are observed in this area[91]. When prevention is no longer an option, and the tide has receded to about 1.2 m, rescuers enter the water and herd the whales away from the shallows and eventually to a boat ramp, where waiting rescuers secure the still-floating animals in stretchers. In the meantime, a flatbed trailer fitted with foam pads is moved in and prepared for transport, a release site selected and permission obtained, and sufficient personnel and equipment gathered to accomplish the mission[79]. This plan minimizes stress to the animals, as well as human effort, and has proven effective even under difficult environmental conditions.

Notes:

Chapter 8
Manatees

8.1. BIOLOGY

8.1.1. Anatomy and Physiology[12,13,79]

Manatees derive from a diverse lineage that dates back more than 60 million years. There are **four living species**: the West Indian manatee (*Trichechus manatus*), in North and South American waters; the West African manatee (*T. senegalensis*), in coastal waters and rivers of tropical western Africa; the Amazonian manatee (*T. inunguis*), restricted to the Amazon River Basin; and the dugong (*Dugong dugon*), a strictly marine form inhabiting the warm coastal waters of the Indo-Pacific from east Africa to Japan. By virtue of their temperature tolerance and herbivorous diets, all modern sirenians are **restricted to the tropics and subtropics**.

Like cetaceans, manatees have streamlined bodies with no external ear pinnae or hindlimbs (Fig. 8.1). They have a paddle-shaped, horizontally flattened tail adapted for propulsion, not speed. The mobile flippers are used to gather food, and sometimes even to support the fore-body during bouts of browsing on shoreline vegetation[77]. The relatively small head has valve-like nostrils and small eyes, which are closed by a sphincter rather than eyelids—a feature unique among mammals[84]. The fleshy, prehensile upper lips, equipped with stiff bristles[74], are used to gather and manipulate food into the mouth[49]. The molars emerge in the back of each tooth row and migrate forward as the anterior teeth are worn and lost—an adaptation to the grit in the diet that makes the teeth unsuitable for age determination[24].

The manatee's internal anatomy is also unusual (Fig. 10.12). The lungs are thin, elongated, and positioned almost horizontally, each separated from the abdominal cavity by a hemidiaphragm[85]. Adaptations of the gastrointestinal tract reflect their herbivorous diet[80]. A prominent cardiac gland secretes mucus, acid, and digestive enzymes into the sac-like stomach. Plant cellulose is digested in the massive large intestine, which fills most of the abdominal cavity. Together, the large and small intestines may reach 20 m in length, and the full digestive tract of a large adult can

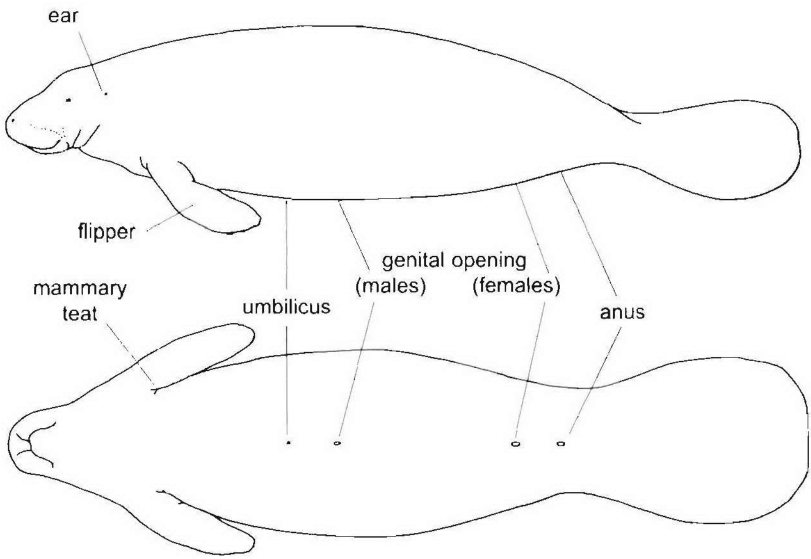


Fig. 8.1. External morphology of the manatee.

weigh about 100 kg. The rate of food passage is slow, about 7 days or longer[86], and digestive efficiency relatively high. The process generates enough methane that flatulence is considered an indicator of good health. Unusually dense, heavy bones (aided by exceptionally dense skin[39]) allow the manatee to submerge with little effort[85].

Manatee sensory systems reflect adaptation to quiet, shallow aquatic habitats. Visual acuity is moderate, perhaps better suited to low light levels in murky waters[3]. The West Indian manatee has a relatively narrow auditory range[33]. Communication relies upon vocalizations and possibly touch, taste, or smell[99].

An unusually low metabolic rate and poor body insulation limit the manatee's ability to tolerate cold conditions[36]**.** They are unable to adapt to water temperatures less than about 20°C, and at temperatures approaching 16°C may become lethargic and stop eating[82,86].

8.1.2. Natural History[34,79,100]

Florida manatees mate primarily during the spring and summer, so most calves are born during warm weather after a gestation period of 11 to 14 months. Cows seek sheltered waters in which to give birth to a single calf, rarely to twins[72]. The nursing period is normally 1 to 2 years, although calves may begin to graze on aquatic vegetation within a few weeks. The interval between births averages 2 to 3 years[46,72]. Both sexes may reach sexual maturity as early as 3 to 4 years[35,46] but may not breed successfully until about 5 to 8 years old. The life span is long, about 60 years.

Other than cow-calf pairs, manatees appear to form no lasting bonds, although short-term bouts of social behavior are common. Females in estrus may be accompanied for up to 4 weeks by a dozen or more males (i.e., a "mating herd"), with different males joining and leaving the group during this time[72]. Vocalizations are common during periods of social interaction and appear to play an important role in maintaining the strong mother-calf bond. The relatively **long period of dependency** may be essential for calves to learn critical survival skills, including the location of specific winter refuges, summering areas, and sources of fresh water[72].

Florida manatees consume a wide variety of aquatic and semi-aquatic plants, and generally forage in shallow waters (1 to 2 m deep) adjacent to deeper channels. While showing some preference for submerged succulent forms, **manatees are opportunistic** and will feed on floating, overhanging, and emergent vegetation, and even algae, detritus, and salt-marsh grasses when preferred plant species are unavailable[4,77]. Where fresh- and brackish-water habitats are limited (e.g., around Puerto Rico and other islands in the Greater Antilles), manatees depend primarily on seagrasses[43,53]. Some individuals may supplement their diets with invertebrates and other sources of protein[21,64]. Manatees feed for 5 to 8 hours per day[8] and consequently linger in areas with abundant vegetation.

The manatee's physiological need for fresh water is uncertain[59]. Their distribution demonstrates a **preference for access to fresh water**, and individuals living primarily in marine habitats frequently drink from any available source, including hoses and sewage outfalls.

When traveling, manatees prefer depths of about 3 to 4 m and are rarely seen in water greater than 6 m deep. They swim at speeds of about 3-7 km/hr, although they may reach 18-25 km/hr for brief periods when frightened. Resting animals can remain submerged for 20 minutes or more. Use of the open ocean is generally limited to travel between favored habitats.

8.1.3. Distribution[43,79]

The West Indian manatee is divided into two subspecies[25]: the Florida manatee (*T. m. latirostris*), restricted to the southeastern U.S., and the Antillean manatee (*T. m. manatus*), which ranges from the southern Gulf of Mexico and Caribbean southward along the Atlantic coast to Brazil (Fig. 8.2). Recent genetic studies suggest that manatees in the Greater Antilles may be more closely related to those in Florida than to those in Mexico or Central or South America[31].

The West Indian manatee's range in latitude is restricted by water temperature (about 24°C). Within this range, **distribution is linked to suitable habitat**: protected shallow waters (preferably rivers and estuaries), abundant aquatic vegetation near deeper channels, sources of fresh water for drinking, and

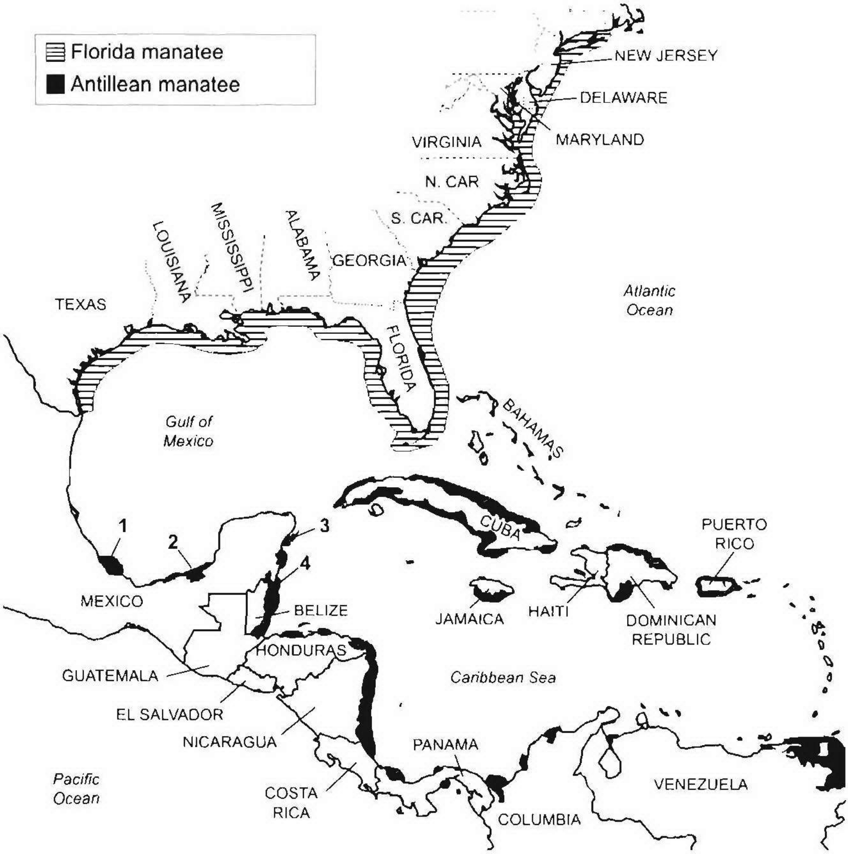


Fig. 8.2. Known or suspected distribution of the West Indian manatee in North America. Areas of relative abundance of the Antillean manatee in Mexico: **1.** Veracruz; **2.** Tabasco and Campeche; **3.** eastern Quintana Roo; **4.** Chetumal Bay. Modified from Lefebvre et al. 2001[43].

availability of warm water during cold weather. Deep water, cold currents, and extensive unprotected coastlines with unvegetated sandy beaches or rocks may act as geographic barriers.

The Florida Manatee[43,93]

The Florida manatee population centers around peninsular Florida (Fig. 8.3). There are four regional populations: the **northwest** (southern Big Bend area), **southwest** (Tampa Bay southward), **Atlantic** (including the lower St. Johns River), and the **upper St. Johns River**. The Atlantic and southwest subpopulations contain the large majority of animals. There is little interchange between the Atlantic and Gulf coast populations[75]. From about April through October, manatees range widely[23,75,76]. On the Atlantic coast, **local concentrations** are found in the St. Johns River, the Indian and Banana rivers area, and Biscayne Bay. On the

Gulf coast, areas of greatest concentration include the Suwannee, Crystal, and Homosassa rivers and coastal waterways of the southern "Big Bend" region in the northwest; and, in the southwest, Tampa Bay, the Charlotte Harbor-Caloosahatchee River area, and the bays and creeks of the Everglades. Increasingly, manatees are using areas away from human disturbance[78].

Manatees frequently travel north to Georgia and South Carolina, and occasionally to Cape Hatteras[69]. Some have wandered as far north as Rhode Island, traveling at rates of up to 50 km per day[23]. On the Gulf coast, manatees are occasionally sighted

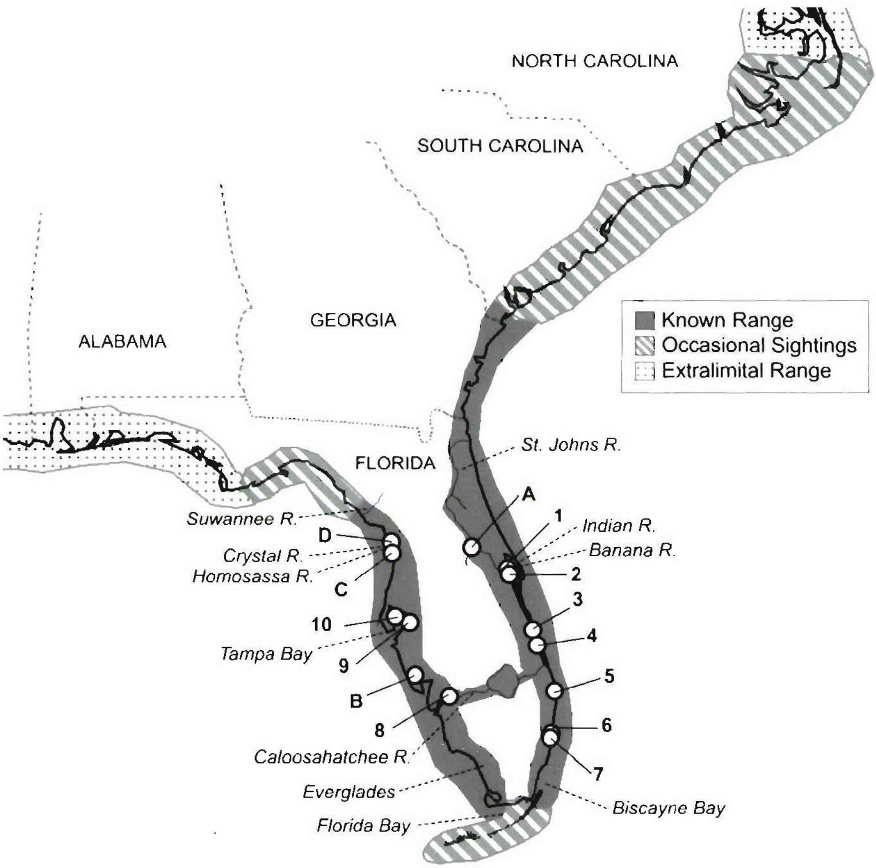


Fig. 8.3. Distribution of the Florida manatee in the United States. Natural (letters) and artificial warm-water refuges (numbers) used by more than 50 manatees: **A.** Blue Spring; **B.** Warm Mineral Springs; **C.** Homossassa Springs; **D.** Crystal River/Kings Bay; **1.** Indian River Power Plant; **2.** Canaveral Power Plant; **3.** Vero Beach Power Plant; **4.** Ft. Pierce Power Plant; **5.** Riviera Beach Power Plant; **6.** Ft. Lauderdale Power Plant; **7.** Port Everglades Power Plant; **8.** Ft. Myers Power Plant; **9.** Big Bend Power Plant; **10.** Bartow Power Plant. (Modified from Lefevbre et al. 2001[43], Marine Mammal Commission 2004[45].)

in Louisiana and Texas, possibly as strays from Mexico[25,67]. Storms and unusual weather patterns may contribute to extralimital movements[41]. Known individuals from the Florida west coast population have been observed near the **Dry Tortugas** and in the **Bahamas**, presumably carried there by offshore currents.

In winter, most Florida manatees retreat to warm-water refuges (Fig. 8.3). Historically, these were freshwater springs, basins, sinks, and lakes in southernmost Florida, with water temperatures above 20°C[36]. In the past few decades, warm water effluent from power plants has provided additional wintering sites as far north as Tallahassee and southern Georgia[75]. **Important wintering areas** along the Gulf coast now include the headwaters of the Crystal and Homosassa rivers[34,71], power plants in Tampa Bay and at Ft. Myers[81], and inshore waters of the Everglades. Along the Atlantic coast, most manatees move southward, while a few remain near power plants at Indian River and Cape Canaveral[75,81]. Manatees in the upper St. Johns River winter primarily at Blue Spring, approximately 250 km from the ocean[61].

Many manatees return to the same site each year and spend the entire winter within a few kilometers of a single warm water source; others may use several sites within the same season[33,72,75,76]. Judging by the presence of attached algae and barnacles, some spend substantial time in saline waters[34]. Manatees normally leave warm-water sites in March, even earlier in mild winters.

The Florida manatee's population in 2005 was estimated at more than 3,100 animals. While the northwest and upper St. Johns River subpopulations have grown dramatically since the 1970s, the larger southwest and Atlantic subpopulations might be declining[42,87]. Apparent overall growth in the past few decades is attributed to increased protection, more artificial warm-water refuges, and greater abundance of exotic vegetation. The main threat to their sustainability continues to be Florida's rapidly growing human population[65,78].

<u>The Antillean Manatee in North America</u>[43,79]

The broad range of the Antillean manatee extends from the southern Gulf of Mexico to Bahia, Brazil, although occurrence is fragmented (Fig. 8.2) and populations generally small (i.e., a few dozen to several hundred).

Manatees are found in small numbers around those islands of the **West Indies** with suitable habitat, including Puerto Rico, Jamaica, Haiti (rare) and the Dominican Republic, and Cuba. With limited availability of navigable rivers, manatees are most often found in coastal marine habitats with shallow, protected bays, extensive seagrass beds, and access to fresh water. Aerial surveys have counted approximately 100 manatees living around Puerto Rico[55], with the highest numbers on the eastern and southern shores[53]. Occasional sightings in the southeastern Bahamas may represent strays from Florida, Cuba, or other areas of the Greater Antilles.

Manatees are patchily distributed from the southern Gulf of Mexico and the Caribbean coast of **Central America** to eastern Panama. In **Mexico**, they are presumed abundant in some rivers in Veracruz and in the extensive wetlands of Tabasco and southern Campeche[57,58]. The greatest concentrations are found along the Caribbean coast of Quintana Roo, especially in Chetumal Bay, which is shared with Belize, the country with perhaps the largest manatee population in the Caribbean. Areas of particular importance include southern Chetumal Bay, the cays east of Belize City, Southern Lagoon along the central coast, and Placencia and Indian Hill lagoons in the south. Manatees may also be relatively abundant in eastern Honduras and Nicaragua[38], where there are generous areas of favorable habitat.

Distribution of the Antillean manatee is sometimes linked to rainfall. In the wetlands of Tabasco, for example, manatees move upriver during the rainy season to forage on abundant vegetation and return to estuaries and coastal areas during the dry season, as water levels drop and food resources dwindle. Seasonal aggregations have not been reported.

8.2. MORTALITY

8.2.1. Natural Mortality[1,13,62,93]

Manatee mortality in Florida has been investigated since 1974. Because carcasses decompose rapidly in warm waters, the cause of death was undetermined in at least 25% of cases. About 20% of all deaths were attributed to natural causes such as disease, starvation, cold stress, and biotoxin poisoning; another 21% were considered perinatal, a category that includes aborted fetuses, neonates, and calves. The remaining cases, about one-third of all deaths, were caused by human activities (*see* **8.2.2**).

Natural mortality is highest among calves, especially those abandoned or orphaned. Calves may lose their mothers due to natural (e.g., disease) or human-related factors (e.g., disturbance, watercraft injuries). Reproductive complications leading to abortion or stillbirth also may contribute to significant losses. Again, the underlying cause may be natural (e.g., anatomical or physiological constraints in young mothers[46]) or human-related (e.g., watercraft injury to pregnant females).

In the southeastern U.S., many manatee carcasses are recovered in winter following periods of extreme cold. While some manatees die from hypothermia, those chronically exposed to suboptimal temperatures often show a range of conditions that together constitute the **manatee cold stress syndrome**[17]. These include emaciation, dehydration, skin lesions and infections, heart damage, enterocolitis, and reduced gastrointestinal tract activity. The latter may reduce buoyancy, further increasing metabolic stress[10,85,86]. In addition to metabolic and nutritional effects, cold stress impairs immune function, inviting secondary

infections, particularly of the skin and lungs[17]. At particular risk are independent juveniles and subadults, with an unfavorably higher surface to volume ratio and little experience locating warm-water sources[19], and some manatees in southernmost Florida that are away from artificial warm-water sites. Unusually high mortality has occurred in at least six winters since 1974, with deaths due to cold stress in some years accounting for more than 20% of total deaths. In Puerto Rico, where cold stress does not occur, the mortality rate for independent juveniles and subadults is relatively low[55].

Severe storms may play a role in manatee mortality. Hurricanes or winter storms have been linked to live manatee strandings and reduced adult survival in northwestern Florida[41], and to increased extralimital sightings in Louisiana and Texas[43]. Anecdotal evidence suggests that manatees have not returned to certain areas of the Yucatan Peninsula since Hurricane Gilbert in 1988[58]. Storm-related sirenian mortality has been documented in Australia, where cyclones have left dugongs stranded on mudflats[48] or, in combination with floods, destroyed vast areas of seagrasses, resulting in large-scale emigration and starvation[68].

Manatees in southwest Florida are commonly exposed to low levels of **brevetoxin**, a neurotoxin produced by the "red tide" dinoflagellate *Karenia brevis* (formerly *Gymnodinium breve*). Red tides in the eastern Gulf of Mexico originate offshore from central Florida, usually in late summer or early fall, and typically last into January. Inshore movement is associated with intrusion of oceanic water into coastal areas[89] or other factors that result in salinities greater than about 27 parts per thousand.

Die-offs due to high-dose or prolonged exposure to brevetoxin occurred in late winter/early spring 1982, 1996, 2002, and 2003, involving about 37, 149, 35, and 98 animals, respectively[28,45]. Manatees in the 1982 event died presumably after incidentally ingesting contaminated ascidians[64]. Animals were disoriented and needed support at the surface to breathe; deaths were probably due to inhibited respiration and inability to surface. Many manatees apparently recovered after a brief period of neurological dysfunction. In the more severe 1996 event, an unusually strong red tide had moved into important feeding areas just as manatees were dispersing from warm-water sites. Some died rapidly, others after chronically ingesting toxin and inhaling toxic aerosols, which can contain concentrations of toxin much higher than those in the water[66]. In addition to neurologic effects, acute exposure caused fatal toxic shock; for the first time, consistent multi-organ lesions were correlated with the presence of brevetoxin[14]. By impairing immune function, chronic exposure may also increase susceptibility to disease[14,96]. Manatees in southwest Florida face the possible additive effect of cold stress, which also suppresses immune function[17].

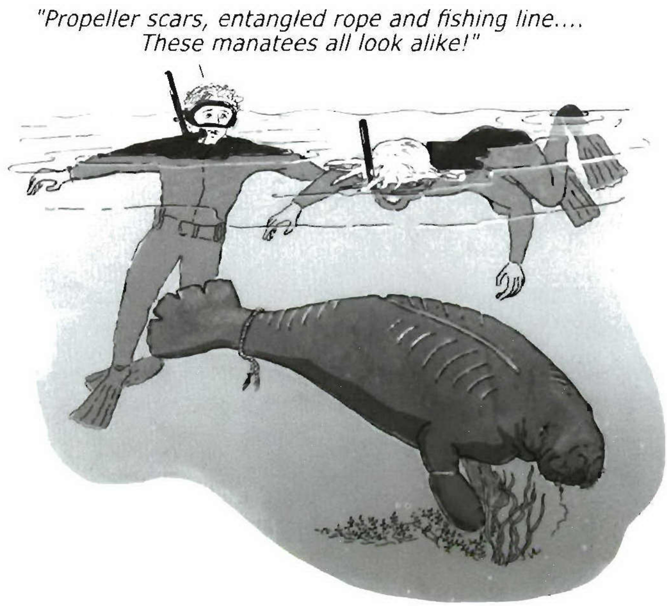
Manatees acquire other diseases, too. Parasitic infections are common but typically not debilitating[6,19,29,54]. The few reports of infection by potentially serious parasites or pathogens include one case of fatal encephalitis due to *Toxoplasma gondii*[18] and serological evidence of exposure to cetacean morbilliviruses[26]. One virus, consistent with a bovine papillomavirus but unique to manatees[73], has been associated with clinical disease: several captive manatees developed multiple benign tumors, or viral papillomas, on the skin—perhaps associated with suboptimal water temperatures[16].

Manatees are prone to chronic skin abscesses from which *Staphylococcus aureus* is frequently isolated. Other **bacterial infections** (e.g., *Pseudomonas* sp., *Morganella morganii*, and *Edwardsiella tarda*) generally occur secondary to cold stress, emaciation, or trauma[17,29,98]. Calves are particularly vulnerable to intestinal infections[97,98]. A few cases of fatal mycobacteriosis, caused by *Mycobacterium marinum* and *M. fortuitum*, perhaps associated with suboptimal temperatures, have been reported in captive manatees[88].

The general absence of infectious disease is remarkable considering that the manatee's habitat may be contaminated with pathogens from a wide range of terrestrial and aquatic animals. Some resistance is undoubtedly conferred by their effective immune system[12]. Still, serologic studies suggest that Florida manatees are exposed to organisms known to cause disease in other mammals, including one or more strains of *Leptospira*[44] (*see* **5.2.1**). Although disease outbreaks have not been observed, such events would be more likely to occur in winter or early spring, when manatees are aggregated in large numbers at wintering sites.

8.2.2. Human-Related Mortality[12,43,62,93]

The Florida manatee lives in close proximity to dense human populations throughout most of its range. Not surprisingly, **human activities are directly responsible for about one-third of manatee deaths, with watercraft collision the principal cause**. Some animals die from propeller wounds, frequently seen as a series of parallel marks along the back. Due to the manatee's unusual anatomy, propeller wounds may penetrate a lung, often with fatal results. The majority of deaths are due to internal injuries caused by vessel impacts, which sometimes leave no external wounds[102]. Less seriously injured animals may survive but with injuries that reduce breeding success. Since the mid-1970s, more than 2,000 individuals have been identified by their scars—most from boat injuries, and many with scars from multiple strikes and with severe mutilation of the tail and back[7,65]. The number of manatees killed by watercraft has increased in all areas of Florida over the past two decades. Vessel impacts kill a disproportionate number of adults, the age group whose survival is most important for population growth[47].



Relatively few Florida manatees die directly from other human-related causes, which include entanglement in fishing gear, entrapment in culverts, ingestion of foreign material such as fishhooks or plastic[5], and being crushed in navigation locks or flood-control gates. More important is **habitat degradation and loss**: the aquatic vegetation they depend on is vulnerable to poor water quality; their natural warm-water refuges are threatened by groundwater depletion; and industrial refuges are subject to failure or closure[60,78]. The effects of degraded habitat on population health might be evidenced as increasing rates of perinatal death, cold stress, and disease-related mortality.

Human-related mortality threatens Antillean manatees throughout much of their range. In Puerto Rico, manatees comprise a major portion (>40%) of all marine mammal strandings[55]. Since 1990, human interactions have accounted for almost half of all deaths. In recent years, watercraft collision has become the most common cause of human-related mortality in Puerto Rico. Hunting, opportunistic take by fishermen, and entanglement in nets account for the majority of human-related manatee deaths in Mexico[57,58] and other areas of the Caribbean[38]. In some areas, such as southern Quintana Roo and Belize, habitat loss due to expanding human populations and tourism has become a major concern.

8.3. STRANDING RESPONSE

8.3.1. Jurisdiction[78,93]

The **West Indian manatee** is protected in U.S. waters by the Marine Mammal Protection Act of 1972 and the U.S. Endangered Species Act of 1973; the U.S. Fish and Wildlife Service (FWS) has federal responsibility for manatee conservation and for federal law enforcement. The Florida manatee is further protected in Florida by legislation enacted in 1893 and 1907 prohibiting hunting; by the Florida Endangered and Threatened Species Act of 1977; by the Florida Manatee Sanctuary Act of 1978, which established the state of Florida as a sanctuary for manatees; and by various federal, state, and county manatee protection initiatives (e.g., refuges, sanctuaries, and boating speed zones[45]). The Florida Fish and Wildlife Conservation Commission (FWC) has state responsibility for manatee protection and conservation. The Florida Manatee Recovery Plan, initiated in 1980 by FWS and drafted by an inter-agency team of specialists (Manatee Recovery Team), recommends specific strategies for population recovery. The FWS and FWC share responsibility for carrying out these activities by coordinating all agencies and organizations involved in Florida manatee research and management.

The network of federal, state, and other agencies responsible for responding to manatee strandings is organized and extensive. The FWS issues permits for rescue, rehabilitation, capture, and related captive program activities. Separate permits for state and federal research are held by the FWC's Fish and Wildlife Research Institute (FWRI, formerly Florida Marine Research Institute) and the U.S. Department of Interior U.S. Geologic Survey's Sirenia Project, respectively. The manatee carcass salvage program was initiated in 1974 by the FWS (Sirenia Project) and the University of Miami and transferred to the state in 1985. Acting under authorization from FWS, FWRI is now responsible for routine rescue and for the carcass salvage program (conducted by the Marine Mammal Pathobiology Laboratory, St. Petersburg, FL).

Reports of dead or injured manatees are verified by FWC Law Enforcement; FWC is then responsible for carcass retrieval, transport to a facility, and necropsy according to detailed protocols[10,83]. Only trained, designated personnel may remove and necropsy carcasses or rescue distressed manatees. Critical care and rehabilitation are undertaken by authorized private oceanaria, through state funding and other means.

Following the 1996 brevetoxin-related manatee die-off, contingency plans were released by the FWS[92] and the Florida Department of Environmental Protection[32]. The combined plans[27] include guidelines for recognizing unusual events and initiating a response, and for establishing roles for the many partners involved in manatee conservation and protection.

Antillean manatees in Puerto Rico and the U.S. Virgin Islands are protected under U.S. federal legislation. Manatees in Puerto Rico are also protected by several Commonwealth of Puerto Rico laws[43]. Originally included in the FWS Florida Manatee Recovery Plan, a separate recovery plan for this population was developed in 1986[70]. Carcass salvage efforts initiated by the FWS (Sirenia Project) in 1974 were taken over by the Caribbean Stranding Network in 1989; this organization also coordinates manatee rescue and rehabilitation efforts[55].

The Antillean manatee is officially protected in other Caribbean countries, but enforcement in most areas is an ongoing problem. In Mexico, the manatee is protected by the Ecological Act of 1994; recent conservation measures include development of a recovery plan and establishment of protected areas (e.g., in Chetumal Bay)[43]. National and international efforts are underway to develop and expand manatee conservation programs throughout the Caribbean and Central America[2,30,78].

8.3.2. Evaluating the Event

Manatees move slowly, often rest motionless at the surface or near the bottom, and may wander into any accessible waterway, even in populated areas[34,56]. A solitary calf may be left alone temporarily while its mother feeds. Mating activities include aggressive behavior that may be misinterpreted as distress. Manatees are also prone to "bloat," a condition that may leave them temporarily unable to submerge, but one that normally "passes" (i.e., look for bubbles) in a matter of days. **Careful, prolonged observation of the animal's behavior, breathing rate, and position in the water is necessary to determine whether intervention is necessary.** In U.S. waters, only authorized individuals may make this decision.

Some manatees unable to function may strand ashore; most remain in the water. Fresh propeller wounds, entanglement, entrapment, weakness, emaciation, prolonged inability to submerge, difficulty in surfacing, listing to one side, reluctance to move or suckle, and labored breathing are signs of distress. (The normal respiratory rate is about one breath every 1 to 2 minutes when active and traveling and every 5 to 15 minutes when resting on the bottom.) An unaccompanied calf, an animal far from its normal range, and those unable to reach warm water during the winter will also need assistance.

In southwest Florida, manatees exposed to brevetoxin may need help. Signs of neurologic dysfunction may include disorientation (e.g., swimming in tight circles or colliding with pilings or seawalls), inability to submerge or maintain a horizontal position, flexing of the back, labored breathing, chewing movements and flaring of the lips, and lack of response to prodding[64].

Manatees usually strand alone, or if female, with her calf. A mating herd may temporarily strand; otherwise group strandings are unlikely. Multiple deaths or strandings, not necessarily in the same location, might follow a spell of extreme cold or a red tide. Such events are more likely to occur during the colder months, when manatees aggregate in large numbers.

For manatees outside their normal range, the need to intervene must be weighed carefully. "Chessie," an adult male, was rescued in the northern Chesapeake Bay in October 1994, held briefly at the National Aquarium in Baltimore, and then flown to Florida, fitted with a radio-tag, and released. In subsequent years, Chessie has traveled even further north and returned to Florida with no human assistance[22]. In some cases, wanderers may learn from experience.

8.4. APPROACH AND HANDLING[37,63]

The effort needed to capture a manatee depends on the animal's condition. Severely debilitated manatees may offer little resistance[64], whereas otherwise healthy individuals can thrash and injure themselves or handlers. Approaching a manatee without a capture plan will likely scare the animal away and increase the difficulty of subsequent attempts.

Specific Equipment (*see also* **2.5.2** and Box 2.1)

- nets
- rope
- buckets
- flatbed truck or trailer
- heated truck (live animals in winter)
- stretcher
- foam pad
- crane or winch

One method of capture is to surround the manatee with a net (10- to 20-cm stretched mesh), which is gradually drawn toward shore until the animal is exposed enough for handlers to physically restrain it. (In Florida, specialized boats are used for open-water captures[95].) Up to 15 people are needed to net a healthy manatee. **Handlers must use extreme caution to avoid becoming entangled in the net and dragged into the water.** As soon as the manatee is in shallow water, it is maneuvered onto a padded platform and secured with straps. A 3.5-m-long stretcher will also do, provided it is wide enough to accommodate the animal's large girth. The risk of injury to both the manatee and the handlers is especially high when removing the animal from the water; use firm restraint.

Once out of the water, manatees generally become calm and may need little restraint. They should be approached quietly, from the front. Covering the eyes and wrapping a small piece of netting over the snout (do not obstruct breathing) may help calm the animal. Handlers must be prepared for sudden tail thrashings.

Further restraint, if necessary, may require at least four or five persons; one or two experienced handlers putting their weight on a piece of foam placed over the tail can help control sudden movements[98]. Use extreme caution with this procedure.

Calves can be restrained and supported in the water by a single person but must be placed securely in a stretcher before removal from the water. **One person cannot safely lift a calf**; they are difficult to hold and may be injured if dropped.

Sedatives are sometimes used to safely calm excited, healthy adult manatees for transport.

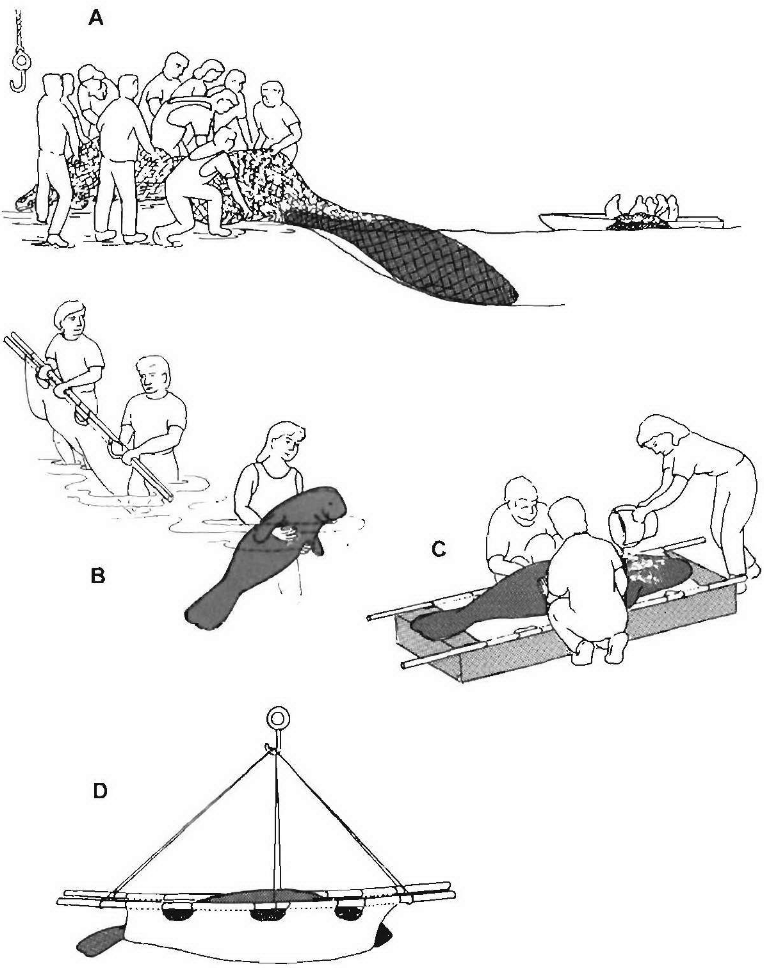


Fig. 8.4. Techniques for manatee handling and transport. **A.** Netting a manatee and drawing it into shallow water or into a skiff (keep the nostrils above water). **B.** Supporting a neonate in the water by grasping it around the pectoral region from behind; **secure in a stretcher before lifting it from the water**. **C.** Transport on a foam pad; keep moist. **D.** Moving adults or large juveniles by means of a crane or block and tackle.

8.5. EVALUATION AND FIRST AID

Once secured and moved into shallow or protected waters, or onto a sandy beach well above the water line, the animal's condition can be evaluated. The normal heart rate is 50 to 60 beats per minute[98]. Signs of malnourishment include a distinct neck ("peanut head") and caudal peduncle, or a sunken abdomen[13]. Manatees struck by motorcraft may have obvious lacerations, but just as frequently there may be little external evidence of damage to ribs or lungs. In either case, little can be done on-site to treat such injuries. Open wounds or injured flippers should be kept protected during handling and transport.

A manatee that has been left stranded on shore by a falling tide should be kept shaded and wet to prevent overheating until it can be examined by qualified medical personnel. Beached manatees have been known to swim away on an incoming tide after several hours of exposure. Cold-stressed manatees should be taken into a warmer environment (i.e., heated truck or warm pool) as soon as possible. Juveniles are particularly prone to hypothermia.

Some manatees affected by biotoxin may be so disoriented they require assistance in raising their heads above the water to breathe[64]. Under most circumstances, however, **attempts to help an unrestrained manatee are ill-advised and dangerous**.

8.6. TRANSPORT TO CARE FACILITY

Rescued manatees are generally secured in a stretcher and transported by truck on a 15- to 20-cm-thick open- or closed-cell foam pad, or in padded transport boxes. Cranes are needed to lift adults. During transport the animal should be kept moist and shaded in a 20° to 26°C environment.

Capture stress (myopathy) does not appear to be a concern[20,63]. Nevertheless, it is always best to minimize pursuit, vigorous handling, and transportation time.

8.7. REHABILITATION[13,98]

On arrival at the rehabilitation center, the manatee should receive a thorough physical examination, including routine blood analyses and a rectal exam to determine gastrointestinal tract function. Blood is drawn, using an 18- or 21-gauge needle on an extension set, from either the lateral or palmar side of the flipper between the radius and ulna[15] (*see* Fig. 10.4). All venipuncture or injection sites must be carefully cleaned of bacteria and algae to reduce the risk of infection. Normal blood values have been reported for Antillean[20] and Florida manatees[15,50,51]. Analysis of blood glucose is especially important for orphaned calves and those

with symptoms of cold stress. Blood can also be useful for determining exposure to brevetoxin if samples are collected within an hour of exposure, although toxin may disappear too quickly for this to be of significant practical value.

Other recommended samples include urine (a strategically placed Frisbee is useful) and other discharges, fecal samples, and biopsies of any skin lesions suspected to be part of the clinical pattern of illness. Except for suspected flipper damage, the use of radiographs and other imaging techniques can be limited by the manatee's size and unique anatomy. Ultrasound can be useful for evaluating skin and abdominal abscesses, diagnosing pregnancy, and determining the thickness of subcutaneous fat layers[9].

Manatees should be maintained in water ranging from **25° to 30°C** (30° to 32°C for neonates[90]). Animals with buoyancy problems can be supported using neoprene flotation jackets, which have the added advantage of reducing heat loss. Manatees held in brackish or salt water must be offered **fresh water for drinking**. While calves have been held successfully in small wading pools, longer-term rehabilitation needs are best met by providing facilities that approach or meet standards for captive marine mammals[91]. **A good filtration system is essential** to manage the heavy fecal load and dietary debris.

Manatees with clinical signs of brevetoxicosis are treated with steroids and nonsteroidal anti-inflammatory drugs in addition to supportive care. Those with cold-stress syndrome may require antibiotic therapy as well as daily antiseptic scrubs for treating bacterial and fungal skin lesions; good water quality is essential. Oral antibiotics may cause diarrhea, with loss of normal intestinal flora, and are generally not recommended.

Extremely ill or dehydrated animals often have poor gastrointestinal function and require treatment for constipation. Fluids are administered by stomach tube. Once rehydrated, the animal is fed using a stomach tube to deliver a gruel of ground lettuce, spinach, and water; the mixture is gradually thickened when fecal production and flatulence are observed. Once food intake is normal, a process that may require several months, manatees can be offered a variety of green plants, including lettuce, cabbage, spinach, celery, carrot tops, natural water grasses, water hyacinth, and sometimes seagrasses. Depending on age, animals will consume about 7 to 15% of their body weight per day. Pre-release conditioning may involve a gradual shift to a more natural diet of seagrasses and freshwater plants. Avoid hand-feeding animals slated for release.

Most manatees entering rehabilitation are orphans. Neonates are generally in critical condition and vulnerable to secondary conditions such as enterocolitis. Artificial formulas[90] have been used successfully to nurse orphans back to health.

Calves should be bottle-fed (or tube-fed if necessary) every 2 to 3 hours using clean, sterile equipment, feeding no more than 300 ml per session[90]. Although calves in the wild may nurse for up to two years, those in rehabilitation can be weaned as early as 8 months of age.

Care of orphaned, cold-stressed, and other seriously ill or injured manatees may require months of intensive treatment and supportive care; many such animals may be non-releasable. An estimated $40,000 per year is necessary to raise a calf with no medical problems; rehabilitation of a seriously injured animal can cost many times that amount[12].

8.8. RELEASE

Less than 25% of manatees rescued in Florida since 1973 were immediately released at the capture site[11]. These were animals that had been trapped or entangled with no signs of serious injury or those poisoned by red tide toxins[64] that had recovered by the time the rescue team arrived.

The decision to release an animal from a rehabilitation facility is made on a case-by-case basis, with authorization from appropriate federal and state agencies. The FWS has developed release guidelines that consider size, origin, and time in rehabilitation as well as health[11,94]. Wild-reared adults, or subadults with experience in foraging, in captivity for less than one year and with no medical problems are the best candidates for release. Juveniles (200 to 275 cm) and those in captivity longer than one year are considered on an individual basis; calves smaller than 200 cm are released only with the mother. Foster-reared and hand-reared calves, and manatees that have been in captivity for long periods, require extensive pre-release conditioning and post-release tracking. Animals in captivity 15 years or longer are considered "conditionally non-releasable" and are evaluated on a case-by-case basis. Releases should take place in spring or early summer in the general area of rescue (i.e., into the appropriate subpopulation).

Animals slated for release are freeze-branded with a unique 5-cm-high number on each shoulder and on the dorsal tailstock (those with identifiable scar patterns are not branded) and are sometimes fitted with a floating radio tag that incorporates VHF, ultrasonic transmitters, and a satellite-monitored UHF transmitter[11,22,40,76]. The unit is attached to a belt around the animal's peduncle by a 1.5- to 2-m-long tether, which is designed to break free if the floating transmitter becomes entangled. Passive integrated transponders, implanted under the skin over both shoulders, allow positive identification of individuals with faded brands or whose transmitters have been lost[101].

Manatees in Florida and Puerto Rico are monitored after release. This may include periodic, scheduled captures to evaluate health[12,52]. About 75% of the manatees studied as part of a post-release monitoring program initiated in Florida in 1988 have readapted successfully[11,22]. The study confirmed the importance of behavioral experience in locating feeding areas, fresh water, and warm-water sites[11].

8.9. EUTHANASIA

Lethal injections of barbiturate have been used effectively.

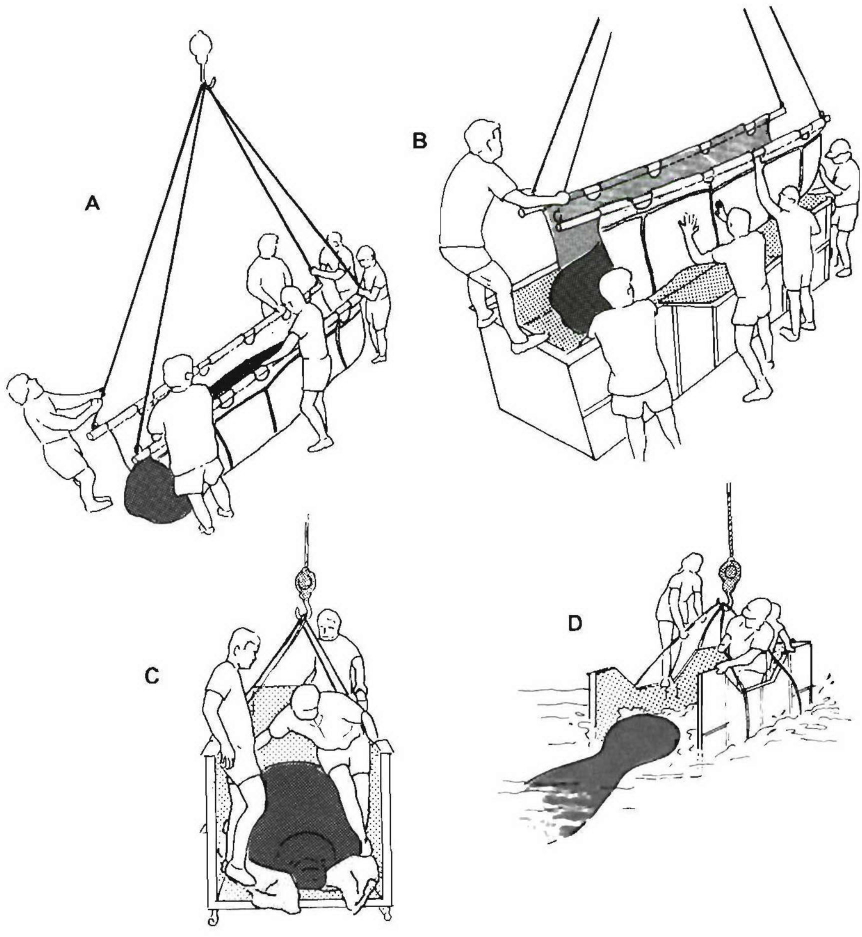


Fig. 8.5. Techniques for transport and release. **A.** Lifting a manatee in a stretcher with a crane. **B.** Lowering a stretcher into a specially designed transport box. **C.** Lowering of transport box into water at the release site. **D.** Release. **Note:** Be prepared for sudden thrashing at all stages. Keep a firm hold on stretcher, poles, lines, and box.

Chapter 9
Sea Otters

9.1. BIOLOGY

9.1.1. Natural History[36,62]

The sea otter, the only exclusively marine mustelid in the Northern Hemisphere, is the smallest, most recently evolved marine mammal. Adaptive features include relatively large lungs that aid buoyancy, kidneys specialized to cope with ingested seawater, hind limbs with well developed flippers, and teeth—powered by strong jaw muscles—adapted for crushing. The sea otter's lack of blubber and absolute dependence on fur for insulation are arguable evidence of an incomplete adaptation to the marine environment. (*See* **15.4** for a summary of general characteristics.)

Fur is the key to sea otter survival. The dense coat, with more than 150,000 hairs/cm^2 over some parts of the body[80], requires vigorous and frequent grooming to remain clean and maintain its loft, which is vital for insulation and buoyancy. When the fur is soiled, water penetrates to the skin and the otter becomes chilled[12,15]. With a **high metabolic rate** and low digestive efficiency, sea otters must consume food equivalent to 20 to 33% of their body weight per day[11]. Their needs escalate in winter, when activity levels must increase to maintain body heat[26].

Sea otters forage in shallow, nearshore waters often with rocky bottoms and kelp beds. Prey selection varies with individual tastes, foraging ability, and prey abundance and diversity[21,27,39]. Under favorable conditions, otters select easy-to-capture, calorie-rich prey such as abalones, sea urchins, clams, and large crabs. In areas with soft sediments, they often dig for clams and other buried prey. When preferred prey are depleted, they must change their eating habits, spend more time searching for food, or move to new feeding areas[26,39]. For example, some long-established populations in Alaska that depleted the supply of bottom-dwelling invertebrates altered their diets to include fish as their primary prey[21].

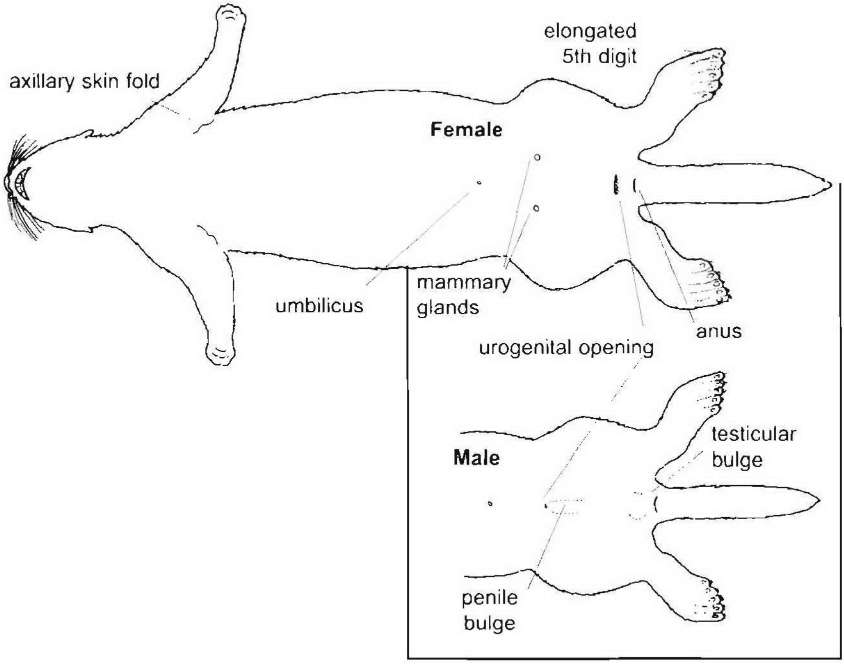


Fig. 9.1. Sea otter external morphology.

Dexterous forelimbs with well developed claws are used for gathering food, feeding, and grooming. Prey items are often carried in loose folds of skin in the axilla. On the surface, an otter swims on its back alternately paddling its hind limbs. Underwater swimming involves vertical undulations of the rear body, hind limbs, and tail.

When not diving for food, sea otters are generally found at the surface eating, grooming, socializing, and resting, commonly in groups or "rafts." They sleep at sea, often wrapping themselves in kelp to remain stationary. Some may haul out to rest, particularly in Alaska, where they also may return to land to give birth, nurse their young, and conserve energy during severe weather[50].

Females reach sexual maturity at 3 to 4 years and males at 5 to 6 years, although neither may breed successfully until they are older[31]. The male bites the female's nose during mating, sometimes inflicting injuries that can lead to infection, scarring, and even death, especially in southern sea otters[37,64]. Pregnancy, including a period of delayed implantation, averages 6 months and the period of dependency 5 to 8 months, resulting in an inter-birth interval of about a year[31]. Most pups are born in late winter to early spring, maximizing their chances of developing adequate foraging skills before their first winter of independence. Maximum age is about 15 to 18 years for females and somewhat less for males.

Male and female sea otters often live apart, with females predominating in more established portions of the range, and breeding males defending territories within the female areas. Other males—juveniles and non-breeding adults—tend to occupy the periphery[25,30]. These males are typically the first to colonize new areas, sometimes traveling hundreds of kilometers in a few days[25,63].

9.1.2. Distribution[32,36,63,72]

There are three **subspecies** of *Enhydra lutris*: *E. l. lutris*, the Asian sea otter, found from the Kuril Islands to the Kamchatka Peninsula and the Commander Islands (western Bering Sea); *E. l. kenyoni*, the northern or Alaskan sea otter, found from Alaska to Washington; and *E. l. nereis*, the southern or California sea otter.

Once abundant in much of the coastal North Pacific, sea otters were reduced to about a dozen remnant colonies by the early 1900s. Populations recovered rapidly following protective legislation in 1911, particularly in southwestern to south-central Alaska. Otters from these areas were successfully translocated to southeastern Alaska, British Columbia, and Washington in the late 1960s and 1970s. By the 1980s, many southwestern and southcentral **Alaskan populations** had reached carrying capacity, and some have subsequently shown dramatic declines[20]. The total Alaskan population, perhaps 100,000 to 150,000 in the mid 1970s, is now nearer 70,000[6,8].

The translocated northern sea otter populations in **British Columbia** and **Washington** have grown. More than 1,500 sea otters (from the original 89) now occupy the west coast of Vancouver Island, and about 500 inhabit a small stretch of the central mainland British Columbia coast[55,75]. After a slow start, the colony along Washington's northwestern coast has grown by nearly 10-fold to about 550; strays are occasionally sighted in Puget Sound and the San Juan Islands[33,40,61].

The southern sea otter—once numbering less than 50 and now exceeding 2,500—occupies a 500-km (~300-mile) stretch along central and southern **California** (Fig. 9.2). This population is slowly expanding southward (with occasional sightings along the Baja Peninsula[24]), but growth has been slow compared to other recovering populations. Efforts to establish a breeding colony on San Nicolas Island in the late 1980s met with little initial success, despite numerous births[57]. This small colony (estimated at 33 in 2003) has shown recent signs of growth[44].

9.2. MORTALITY

9.2.1. Natural Mortality[23,36,37,52,66]

Sea otter mortality varies regionally, seasonally, and with age. **Survival depends on clean, well-groomed fur and frequent, successful foraging.** Throughout the range, winter and spring storms bring otters ashore suffering from trauma,

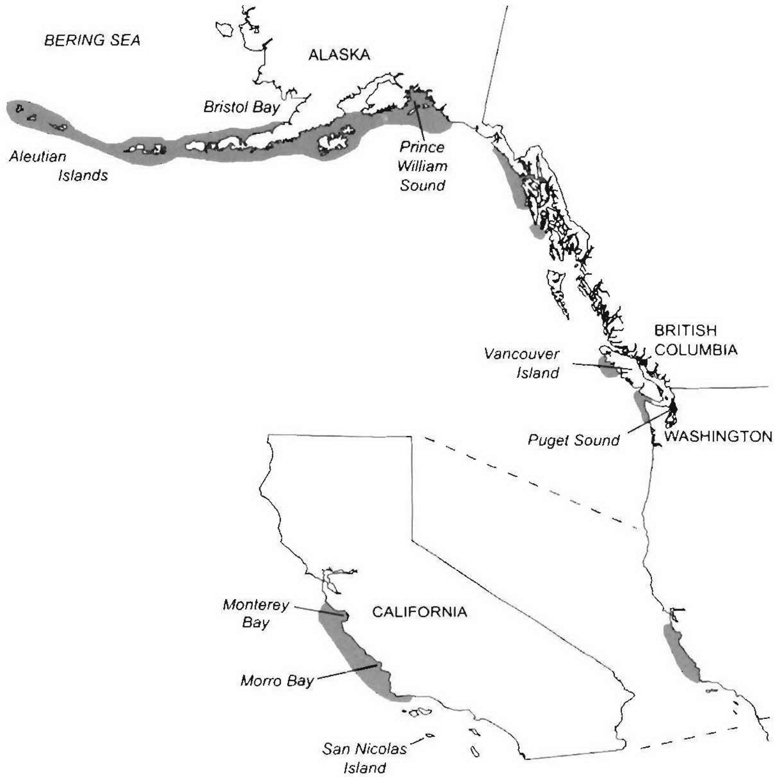


Fig. 9.2. Sea otter distribution in North America.

exposure, and emaciation due to increased difficulty in obtaining prey. Reduced prey availability contributes to mortality any time of year. Dependent pups, juveniles, and old animals with worn teeth are most vulnerable.

Predators can take a heavy toll. In Alaska and British Columbia, eagles sometimes prey on pups, while coyotes may kill juveniles that haul out on land[50,75]. Killer whale predation may be a major factor in the dramatic decline of sea otters in the Aleutian Islands, presumably a consequence of the reduced abundance of harbor seals and Steller sea lions, the whales' preferred prey[20,22]. Great white sharks are a threat in California, particularly in the northern part of the range. Recent studies suggest that shark attacks may be triggered by abnormal behavior associated with protozoan encephalitis (*below*).

Additional causes of natural mortality noted prior to the 1990s included complications during birth, wound infection following mating or fighting, intestinal parasitism, gastrointestinal tract obstruction, and stress-induced enteritis. Infectious disease was not recognized as a significant cause of death.

A systematic necropsy program initiated in 1992 has revealed a different picture for southern sea otters. Mortality is highest in spring through late summer, when conditions are generally mild, and is high among prime-age adults. Disease-related mortality—involving conditions unrecognized or uncommon before 1992—increased to more than 60% of diagnosed deaths by 2001. In part, these numbers reflect greater necropsy effort and better diagnostic techniques. Still, this trend suggests increased exposure or susceptibility to pathogens, or exposure to novel or more virulent strains—in any case, conditions less favorable for population growth.

Parasitic disease has accounted for about 40% of deaths in recent years. Peritonitis associated with the **acanthocephalan** *Profilicollis* sp. is a leading cause of death, particularly of juveniles and older female sea otters in Monterey Bay[45]. Unlike *Corynosoma*, a related sea otter parasite, *Profilicollis* actively penetrate the intestinal wall[29]. Otters probably ingest *Profilicollis* when feeding on mole crabs (*Emerita* sp. and *Blepharipoda* sp.)—intermediate hosts for these seabird parasites[45]. These crabs, while not preferred prey, are abundant in sandy-bottom habitats and may be more easily captured by young or debilitated animals.

Encephalitis caused by the **protozoan parasites** *Toxoplasma gondii* and, to a lesser extent *Sarcocystis neurona*—also reported in northern sea otters from Washington[43]—is the other leading cause of death in this population, particularly of adults in Morro Bay (central California)[10,46]. *Toxoplasma* infection, often without obvious signs of illness, is common in both the California and Washington populations[48]. The high mortality rate in Morro Bay has been linked to infection with an unusual genotype of *Toxoplasma*[49]. Recent studies have also found a link between protozoan encephalitis and both shark attack and heart disease: the latter is an important, emerging cause of death, particularly of adult females. Cardiac disease, in turn, may increase vulnerability to severe nose wounds in both males and females. These findings suggest that *Toxoplasma* infection may have a far-reaching impact on sea otter health and survival. Cats and opossums (*Didelphis virginiana*)—the definitive hosts for *T. gondii* and *S. neurona*, respectively—are the probable source, with oocysts shed in feces presumably carried in runoff or sewage into nearshore waters and then concentrated in filter-feeding invertebrates upon which the otters prey[10,47].

Coccidioidomycosis, caused by the soil fungus *Coccidioides immitis* and generally associated with terrestrial animals, is occasionally reported in southern sea otters. A small outbreak between 1992 and 1994 coincided with a regional increase in human cases, which were attributed to unusual environmental conditions. The otters presumably inhaled fungal spores transported from land by offshore winds.

Few viruses have been reported in this species. One is a **herpes-like virus**, associated with mouth lesions and probably secondary to debilitation and stress in Alaskan sea otters[60]. Otters in Washington are commonly seropositive for **morbillivirus**[13], with no evidence of clinical disease. However, other mustelids, including some river otters in Alaska and British Columbia, are susceptible to canine distemper virus, also a morbillivirus, presumably contracted from terrestrial carnivores[53].

Bacteria are generally not significant primary agents of disease in sea otters but, as opportunistic pathogens, commonly kill those weakened by other conditions[23]. *Leptospira*—apparently the same serovar that causes **leptospirosis** in California sea lions (*see* **5.2.1**)—may be an exception. This disease was suspected or confirmed in several otters that died in an apparent outbreak in Washington in 2002[13].

Biotoxins may be a growing threat. An unusual mortality of Alaskan sea otters in 1987 was circumstantially linked to paralytic shellfish poison (**saxitoxin**) in mussels and clams[17]; subsequent studies suggested that otters may be able to detect and avoid prey contaminated with saxitoxin[38]. More recent events in California suggest a greater vulnerability to **domoic acid**, a neurotoxin produced by the diatom *Pseudonitzschia* spp. While only a few cases of fatal intoxication were confirmed in sea otters during the 1998 and 2000 *Pseudonitzschia* blooms along central California, many more otters may have been affected[74]. *Pseudonitzschia* blooms may be increasing in frequency in much of the otter's North American range[68,74]. The risk to Washington and British Columbia populations could increase if they expand into areas where razor clams—a favored prey known to accumulate high levels of domoic acid[68]—are abundant. Like other marine mammals[42], sea otters may be vulnerable to the sublethal effects of ingested toxin (*see* **6.2.1**).

9.2.2. Human-Related Mortality

Restricted to nearshore waters, sea otters are vulnerable to human activities. For the southern sea otter, deaths associated with "pathogen pollution" of coastal waters[10,48] have blurred the distinction between natural- and human-related mortality. Certain human factors are, however, clear-cut. In Alaska, native hunters legally take several hundred otters yearly[59]; in California, otters are more likely to be killed for intruding on fisheries operations. Some are hit by boats or may become entangled in fishing nets[37,72]. **Incidental take** of southern otters in coastal gill- and trammel-net fisheries was believed to be high prior to restrictions on net use over the past two decades[23]. Incidental take and deliberate killing may become greater issues in Washington and British Columbia if otters expand into areas of intense fisheries operations[61,75].

Oil spills are a serious threat. Petroleum vapors, and the light fractions that produce them, irritate and damage the sensitive webbing of the hind flippers and the delicate membranes of the eyes, mouth, and respiratory tract; compounds

absorbed into the circulatory system damage the liver, nervous system, and blood-forming tissues[28,58,84]. Though less acutely harmful, oil that remains at the surface presents an enduring hazard. Fouling robs the fur of natural oils that hold the loft and repel water. The metabolic rate increases to counter the elevated heat loss. The otter becomes so intent on restoring the pelt that it forgoes feeding and resting and, instead, grooms incessantly—spreading and ingesting oil in the process and further damaging the skin and eyes. Sapped of energy, the otter eventually dies of stress and shock[12,78,84].

The 1989 *Exxon Valdez* oil spill in Prince William Sound (Alaska) killed an estimated 4,000 sea otters[18] and likely left survivors with persistent health effects[7,51,86]. Of the approximately 350 otters treated in rescue centers, more than one-third died of lung damage, hypothermia, oil ingestion, stress, and shock; most of those exposed to fresh oil died within days[58,82,84]. Studies in some areas of Prince William Sound 6 to 10 years later revealed the spill's long-term effects on sea otters: elevated mortality rates, low population growth, reduced prey abundance, and evidence of liver damage suggesting ongoing exposure to oil, presumably through ingestion of contaminated prey and contact with residual oil in sediments[7,51].

The effects of **other contaminants** (e.g., organochlorines and butyltins) on sea otter health are poorly understood[35,54]. However, other mustelids such as mink and ferrets are highly sensitive to some organochlorines (including PCBs at levels found in California and Aleutian Island sea otters), with effects that include liver and kidney damage and reproductive failure[3]. These species may serve as good models for understanding the potential impacts of such compounds on sea otter health.

9.3. STRANDING RESPONSE

9.3.1. Jurisdiction

In the **U.S.**, sea otters are protected under the Marine Mammal Protection Act (1972) and managed by the U.S. Fish and Wildlife Service (FWS); associated research is conducted by the U.S. Geological Survey (USGS). The southern sea otter, listed as threatened under the Endangered Species Act (ESA), is further protected by a federal recovery plan[72]. This population is managed and protected by the FWS and the California Department of Fish and Game (CDFG). Although not ESA-listed, the northern sea otter is designated as State Endangered in Washington. In **Canada**, the sea otter is listed as threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and is protected by the Canada Fisheries Act and the British Columbia Wildlife Act. In response to the Species At Risk Act (SARA), enacted in 2003, Fisheries and Oceans Canada is developing a recovery plan[55].

Along U.S. coastlines, sea otter carcasses should be reported to either federal (FWS or USGS) or state authorities (CDFG or Washington Department of Fish and Wildlife). The principal agencies involved in Alaska are the Alaska Science Center (USGS) and the Marine Mammals Management Office (FWS), and in California, the USGS Western Ecological Research Center and the CDFG. The Alaska SeaLife Center, the Vancouver Aquarium Marine Science Centre and, in California, the Monterey Bay Aquarium and The Marine Mammal Center also treat stranded sea otters and retrieve carcasses.

Because beach-cast carcasses may lie undiscovered for days (or longer), the cause of death is often undetermined[37]. A systematic necropsy program for freshly dead southern sea otters was initiated in 1992[66]. All southern sea otter carcasses are now examined at the Marine Wildlife Veterinary Care and Research Center (CDFG) in Santa Cruz, CA[72]. In Washington, all fresh carcasses are sent to the USGS National Wildlife Health Center (Madison, WI); FWS scientists examine other carcasses and collect data.

In the U.S. and Canada, rescue and rehabilitation of oiled wildlife is part of federal, state, and regional oil spill contingency plans. For sea otters, these efforts are supervised by the FWS in Washington and Alaska and by the CDFG in California; responsibility in Canada lies with Fisheries and Oceans Canada. **In all areas, these activities are restricted to agency- and network-trained and approved personnel[5,9,76].**

9.3.2. Evaluating the Event[4,5]

Unless the need for intervention is obvious, sea otters should be carefully observed for up to several hours before any action is taken. Hauling out is a normal behavior in some regions (not California), and a sea otter on shore may simply be resting, about to give birth, or nursing a pup. While healthy animals will typically avoid humans, they may tolerate close approach by a boat. A female otter may dive for food, leaving her pup vocalizing at the surface. **Most situations of this kind do not warrant action.**

Some behaviors signal distress. An otter on shore that appears lethargic, agitated, or reluctant to enter the water, or that makes no attempt to evade capture may need help. Excessive or exaggerated grooming, due perhaps to soiling of the fur, may damage the skin, ears, or eyes[15,84]. Oil-contaminated otters may raise the upper part of the body out of the water and shake vigorously, although this behavior is not necessarily restricted to fouled animals. Otters poisoned by domoic acid may exhibit muscle tremors, abnormal movements, or seizures[37].

More obvious indications of distress include emaciation, wounds, labored breathing, violent shivering, matted fur, and restricted mobility. If the fur appears spiked or retains a slick, wet appearance after more than 10 seconds

at the surface, the otter may be contaminated with oil, and capture should be considered. Moderately or lightly oiled otters may show no significant differences in appearance or behavior.

Sea otters can wander beyond their normal range into unsuitable habitats but are unlikely to remain in areas with inadequate prey. An animal lingering in an unusual location, in distress, or in a dangerous setting, may require assistance. Attempts to herd otters away from danger, or deter them from entering an area, are unlikely to succeed; consider capture and relocation instead.

Large numbers of otters coming ashore, perhaps following severe weather, an oil spill, or harmful algal bloom, can quickly overwhelm a rehabilitation center's capacity. The resources, equipment, and planning needed to rescue and rehabilitate numerous sea otters can be prohibitive[83].

9.4. APPROACH AND HANDLING

9.4.1. Words of Caution

Sea otters can die from the stress associated with capture, transport, and rehabilitation. Evaluate the need for assistance or intervention before subjecting them to unnecessary disturbance. Avoid a prolonged chase; otters alert and active enough to avoid capture may be better left alone. Before rescuing a female, look for a pup nearby, and capture the mother first to prevent her abandoning the pup. If the mother evades capture, move away and allow her to return to the pup before trying again. In this situation, **do not take a dependent pup without its mother or leave a dependent pup behind**; in either case, the pup has little chance of survival.

Appearances are deceiving. **Sea otters have an aggressive temperament**, dexterous forelimbs, forepaws armed with sharp claws, flexible bodies with loose skin, and strong jaws with crushing teeth. **Approach quietly with minimum disturbance, and handle with caution.** Wear heavy leather gloves with long cuffs to minimize serious scratch and bite injuries, bearing in mind that a sea otter can still crush a finger through a glove[5,78,79]. Sea otters are flexible, seemingly able to turn around inside their loose skin; never grab an otter by the tail or nape of the neck. Remember that oiled animals and those with damaged, wet fur are far heavier than those with healthy coats.

9.4.2 Specific Equipment (*see also* 2.5.2 and Box 2.1)

- long-handled dip nets
- tangle nets (modified gill nets)
- transport cages
- restraint boxes
- stuff bags
- net bags
- leather or other heavy gloves
- ice

9.4.3. Capture Techniques[1,2,4,5]

Sea otters can be captured safely only by trained personnel. The most successful methods for water captures use long-handled dip nets, modified gill nets (tangle nets), or specially designed diver-held traps (*see* Box 9.1, Fig. 9.3). Choice of method depends on the experience of the handling team, ocean conditions, condition of the animal(s) to be caught, and the type of habitat. Large-scale captures demand direct communications among the capture crews, support vessels, transport vehicles, and the rehabilitation center. Capture crews should include an animal care specialist (ideally, a veterinarian) to assess each animal's condition and provide immediate supportive care.

On land, dip nets are the most effective means for capturing otters. Approach quietly, and from downwind if possible because of their acute sense of smell[36].

Captured otters should immediately be placed in a transport cage or box. A net bag is the safest way to move an otter to a cage or restraint device. Dip nets, blankets, throw nets, or stuff bags are needed for handling any otter (Fig. 9.4). Blankets or towels can be used to briefly restrain young pups[81], bearing in mind the risk of stress and hyperthermia.

<u>Box 9.1. Equipment for Sea Otter Capture</u>[1,4,5]

Dip nets: When used from 15- to 20-foot skiffs, dip nets are effective, particularly for capturing juveniles in open water. Older animals dive to avoid capture. Cannot be used in rough seas or kelp beds. Requires an experienced boat operator, a net handler to scoop the otter into the net and pull it alongside the boat, and the operator or a third person to help bring the otter onboard and transfer it to a box or transport cage.

Gill or tangle nets: 30- to 100-m long x 3- to 6-m deep nets with 20- to 23-cm stretch mesh, modified by removing or reducing the weighted bottom line so entangled animals will stay at the surface. Useful for capturing active animals too elusive to be taken with dip nets. Require constant monitoring to avoid injuring or drowning trapped animals. Cannot be used in shallow rocky areas or in rough seas.

Diver-held devices: Used to capture resting sea otters, most often in kelp beds. Offers the advantage of surprise and minimizes stress associated with chasing. Not appropriate for captures in areas contaminated by oil or other hazardous materials (for human safety reasons). A capture team includes at least two trained divers and a dive tender.

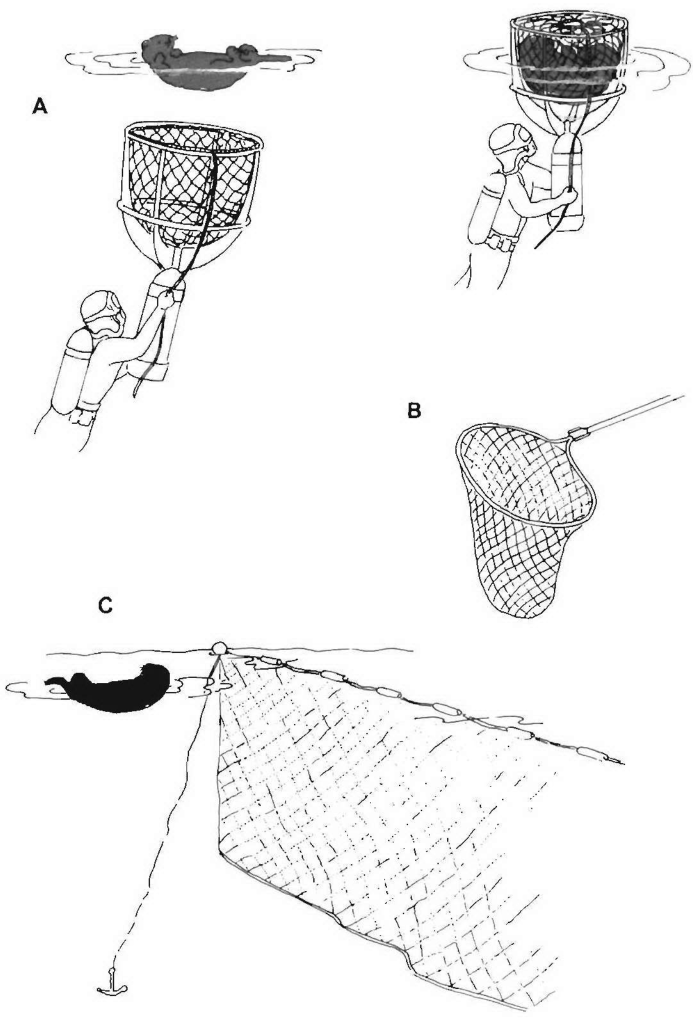


Fig. 9.3. Techniques for capture of sea otters. **A.** Diver-held ("Wilson") trap. **B.** Dip nets. **C.** Modified gill net. (Redrawn from Ames et al. 1986[2].)

Complete restraint is recommended for most physical examinations and sampling procedures. This can be accomplished using a transport cage or restraint box (Fig. 9.4) in conjunction with a stuff bag, or by chemical sedation[78,79]. **Avoid excessive or prolonged physical restraint.**

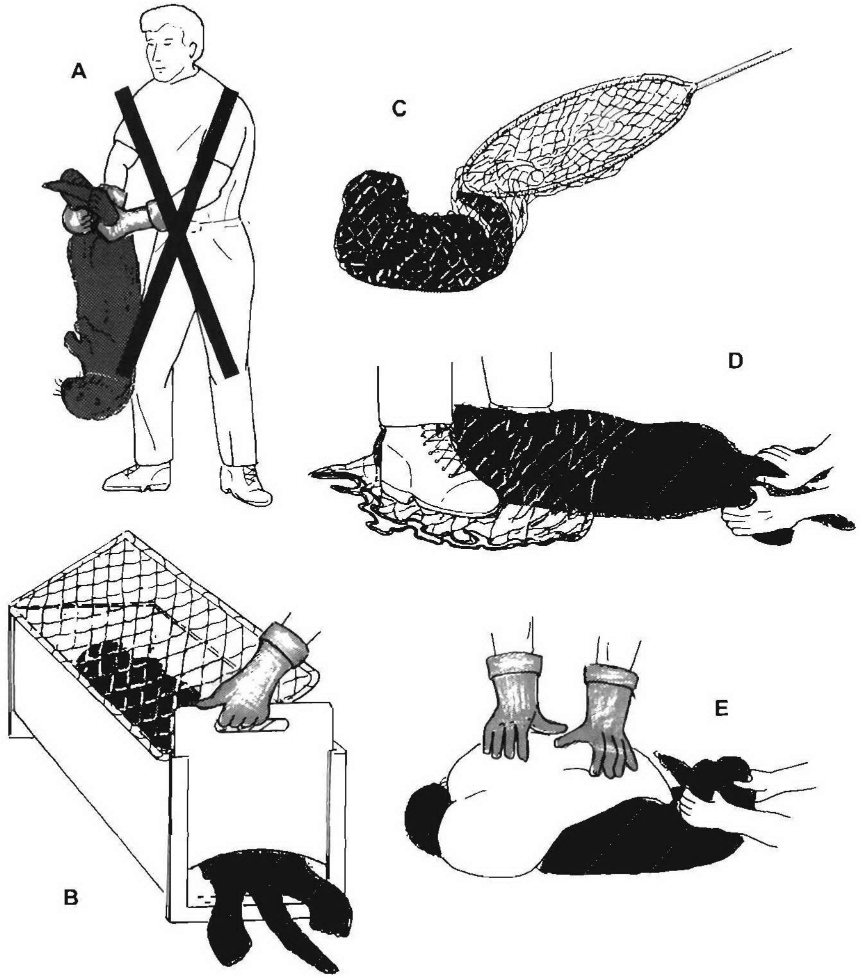


Fig. 9.4. Sea otter handling and restraint. **A.** Do not lift animals by the back legs. **B.** Restraint device. Restraint employing (**C**) dip net, (**D**) tangle net, (**E**) stuff bag.

9.5. FIRST AID

9.5.1. Determining Condition[69,78,81,85]

Evaluate for evidence of respiratory distress (normal rate is 17 to 20 breaths/minute), dehydration, wounds, soiled pelage, emaciation, diarrhea, and shock. Normal heart rate is 144 to 159 beats/minute. As a rough indication of body temperature, the hind flippers should be cool to the touch. Very warm or very cold flippers, or violent shivering or panting, signify thermoregulatory difficulties (Fig. 9.5). To minimize stress, conduct as much of the evaluation as possible from a distance.

The animal's **general condition** may be classified as:

1. **Alert and normal.**
2. **Depressed** (inactive and unresponsive to environmental stimuli but conscious).
3. **Comatose** (retains some simple reflexes but otherwise does not respond).

The course of treatment may depend on the animal's age. A rough guide according to weight is:

1. **Small pup** (less than 3 months, 1-7 kg).
2. **Large pup** (3 to 8 months, 7-20 kg).
3. **Subadult to adult** (>20 kg).

Consider in your estimate that an otter under prolonged stress can lose 25 to 33% of its body weight (mostly from muscle) rapidly[77], and that the weight of an oiled or wet otter will be deceptively high.

9.5.2. Supportive Care[69,78,81,85]

Quickly stabilize the otter's body temperature, treat shock and dehydration, and offer food and water. Signs of **hypothermia** (body temperature <36°C) include lethargy, lack of reaction to handling, cold hind flippers, and violent shivering. Place the animal in a dry cage protected from draft, and warm it gradually with a pet dryer or heat lamp; in severe cases, place the hind flippers in warm water. Rub hypothermic pups with towels until they respond. Oral glucose therapy may be necessary until the otter is conscious enough to accept food.

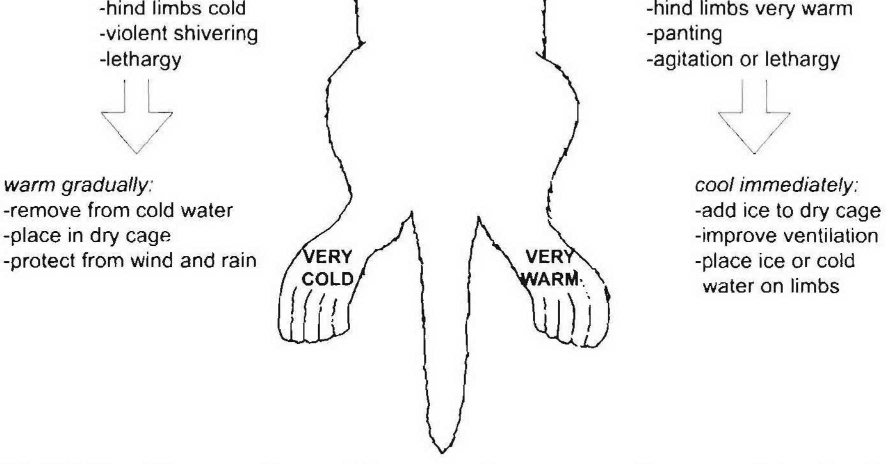


Fig. 9.5. First aid measures for stranded sea otters: the symptoms and treatment of hypothermia and hyperthermia.

Signs of **hyperthermia** (>39.5°C) include lethargy, panting, and very warm, often flared, hind flippers. The condition may arise during captivity or transport when active or sedated animals are confined without access to ice or water. Some oiled otters become hyperthermic through excessive grooming and in response to handling. Hyperthermia may be relieved by using cold or iced water on the hind flippers, or as a bath for immersing the animal. Monitor rectal temperature constantly when warming or cooling a pup.

A note of caution: lethargic, even seemingly comatose sea otters can come around quickly. Never take their behavior for granted.

9.6. TRANSPORT TO CARE FACILITY[5,69,71,78]

Sea otters may be transported short distances (<6 hours) in plastic kennel cages with a removable rack on the bottom to keep the animal from becoming soiled. Ideally, replace the wire mesh door on kennel cages with netting (or make a barrier, e.g., with plastic [PVC] pipe) to avoid injuries from chewing. A double-lidded cooler, with a layer of crushed ice on the bottom, can be used for brief transport of a pup by securing the head and forelimbs in the closed end and leaving the hind limbs protruding from the open half[16]. Unless they are judged to be hypothermic (*see* **9.5**), transport sea otters on a bed of ice shavings or cubes.

For longer transports or prolonged holding out of water (6 to 48 hours), use larger cages made of wood, fiberglass, or metal that have netting side panels, a slotted floor or raised rack in the bottom, and top-mounted doors. These cages must allow good ventilation, unobstructed observation, and easy access for in-transit care. **Provide ice as a source of water and cooling, particularly during warm weather**, and drain accumulated water from the cage. During extended holding or transport, offer food (e.g., shellfish meats, fish fillets, or whole squid) approximately every 2 to 3 hours. Do not overfeed.

Transport as quickly as possible in a well ventilated vehicle, with air temperature below 15°C, lighting adequate for continuous monitoring, and the cages secured to prevent shifting. Include an animal care specialist (ideally, a veterinarian) on the transport team. Have ice or heaters on hand for prompt treatment of hyper- or hypothermia. Water sprayers are useful for cooling healthy otters and preventing further fouling of the fur. Use only chlorine-free water. Helicopters and airplanes are useful for transporting large numbers of otters rapidly.

Before transport or immediately upon arrival at the rehabilitation center, all animals should be tagged in the interdigital webbing of a flipper[4,41].

9.7. REHABILITATION

Sea otters are physiologically and behaviorally demanding and require facilities and programs specifically designed to meet their full range of needs, from critical care to pre-release conditioning. Orphaned newborn pups require individual round-the-clock care by human surrogate mothers[81]. Centers designed for treating oiled otters require additional facilities for triage, cleaning, and pre-release holding[83].

9.7.1. Initial Evaluation[71,78,81,85]

At the care facility, a blood sample should be taken and the animal's condition reevaluated. This includes assessment of body fitness, activity level and behavior, rectal temperature (normally from 37° to 39°C), coat condition, and weight (note whether wet or dry). The initial assessment will dictate whether to treat for **hypo- or hyperthermia, hypoglycemia, dehydration, diarrhea, or shock**[82,86]. The veterinarian may prescribe prophylactic administration of fluids, antibiotics, corticosteroids (use with caution), and nutritional supplements. Females should be examined for signs of pregnancy: pregnant females and those with pups require specialized holding and care[70].

9.7.2. General Husbandry[69,71]

Basic rehabilitation facilities include cleaning areas, dry cages, cages with pools, and floating pens for holding prior to release—all with adequate flow of clean water and good ventilation. The selection will depend on the animal's health and rehabilitation needs. Portable cages are appropriate for seriously ill animals receiving frequent veterinary care or for those recovering from sedation. An otter that is eating, thermally stable, and has no serious medical conditions requires a larger pen with access to a pool at least 0.6 m deep. The next step is an outdoor enclosure with dry space and a pool large enough for swimming, diving, grooming, and socializing. Fully rehabilitated otters awaiting release may be moved to larger, floating pens located in sheltered bays with good seawater circulation.

All enclosures must be designed to prevent injury to the otters' teeth. Use fiberglass pens and cages with rounded interior edges and stretch-mesh panels, and easily washable, smooth plastic or sealed concrete haul-out areas. Avoid exposed fasteners, caulking, and painted surfaces. Inspect the area frequently for missing materials, such as bolts, and "frisk" the otters for clams or other hard objects stored in their "pockets" that they could use to damage the enclosure. Sea otters are agile climbers; enclosures require an overhang, roof, or smooth, vertical walls at least 1.2 m high to prevent escape. **Secure the area from domestic pets.**

Good water quality and clean dry areas are essential at every stage: foul water can quickly damage the fur. Remove uneaten food and rinse haul-out areas regularly. Incorporate surface-skimmers in pools to remove floating debris. **Use**

chlorine-free seawater maintained at 7° to 15.5°C (i.e., similar to seasonal water temperatures in the otter's home range). Chlorine-free fresh water may be used for a few days.

Orphaned pups require constant attention until at least 3 months of age, including regular temperature checks, formula feedings, and careful washing, drying and grooming[81]. By 3 to 4 weeks of age, pups need a shallow (0.6 m) pool in which to develop swimming and diving skills. Once feeding, swimming, and grooming on their own (at 3 to 4 months), they can be moved to an outdoor pool but may still require close monitoring and some surrogate care for several weeks. Overall, rehabilitation may require 6 to 9 months, including a period of weaning the otter from its attachment to humans[81]. Minimize human interaction as early as possible to improve the chances for successful release.

Sea otters are best held in groups of two or more, although adult males and females should be separated, and dominant males may need to be held alone. Watch for signs of stress and fighting among males. Juveniles of both sexes can benefit from placement with adult females. Pregnant females and those with pups should be kept in smaller groups, and females with newborn pups, which need quiet space for nursing, may need separate housing[70,81]. Social bonding contributes to health and well being. **Minimize disruption of stable groups**, and do not separate a pup from its mother unless for health reasons.

Juvenile and adult sea otters thrive on a mixed **diet** of shellfish and fish consumed at a rate equivalent to 20 to 30% of their body weight per day, but they can consume nearly twice as much when unable to maintain their body temperature. Animals with serious health problems should be offered food hourly; for others, divide the daily food allowance into five feedings spaced about 3 to 4 hours apart. Avoid overfeeding healthy animals. Offering a variety of foods is the best way to encourage a reluctant animal to eat. Otters refusing food for more than one or two feedings, or eating less than 10% of their body weight per day require veterinary evaluation. Offer chips and chunks of ice as a source of water.

Pups have often been fed a **formula** containing chopped clam meat and squid mixed with water, milk, whipping cream, Ringer's solution, and vitamins[67,81]. Recent formulas make use of animal milk replacers. The Monterey Bay Aquarium blends 120 grams of Zoologic Milk Matrix 30/55 (PetAg®, Hampshire, IL), 40 grams of Zoologic Milk Matrix 33/40, and 480 grams of cold water to feed sea otter pups. Supplemental fluids are administered subcutaneously to prevent dehydration[34]. The volume and frequency of feeding must be adjusted as rehabilitation progresses, aiming for a weight gain of 1% of the body weight per day, and with solid food gradually replacing the formula[81].

Box 9.2. Care of Oiled Otters[14,78,85,86]

Oil that fouls an otter's fur may also irritate its eyes and skin and cause sinusitis, emphysema, gastrointestinal disorders, liver disease, and intoxication. Therapy may require treatment to manage these conditions, to address any pre-existing problems and stress, and to restore the pelage. Testing blood samples collected within 48 hours of exposure for petroleum hydrocarbons (specifically paraffinic hydrocarbons) may offer a means to evaluate systemic exposure to oil. Categorize oiled otters by degree of contamination:

1. **Heavily oiled** (>60% body coverage with saturation to the skin).
2. **Moderately oiled** (30-60% body coverage that includes areas of saturation).
3. **Lightly oiled** (<30% body coverage or light sheen on fur).
4. **Unoiled** (no obvious evidence of oiling).

Moderately to heavily oiled otters exposed to fresh oil generally display the most serious conditions, including pulmonary distress, thermal imbalance, and hypoglycemia. Clean immediately to minimize further ingestion or absorption of oil. Those that survive the first 2 weeks have a good chance of recovery but may need several months of care for problems such as liver and kidney dysfunction, gastrointestinal disorders, and anemia. For many of these animals, especially those with emphysema, euthanasia may be the most humane option.

Otters contaminated 3 or more weeks after a spill (i.e., by weathered oil) are often lightly or patchily oiled, with fewer medical problems. In these cases, cleaning may be delayed for 12 to 24 hours to allow recovery from the stress of capture and transport, and time for feeding and fluid therapy. For lightly oiled animals, the stress of cleaning may outweigh potential benefits.

Cleaning a moderately to heavily oiled otter requires at least 3 to 4 hours and two or more people and involves the following steps:

1. **Sedation or anesthesia** (to allow safe handling, reduce stress, and permit frequent rectal temperature monitoring).
2. **Physical restraint** on a cleaning table, application of ophthalmic ointment to the eyes (to protect from oil and detergent), and collection of a blood sample.
3. **Repeated washing and rinsing** until no trace of oil is apparent in the fur or rinse water (at least 40 minutes). (Dawn® dishwashing detergent [Proctor & Gamble] diluted 1:16 in water is recommended.)
4. **Thorough rinsing** (for 40 minutes).
5. **Drying**, first with towels, then with a commercial pet dryer set at room temperature (20°C).
6. **Transfer to a cage for recovery from sedation.** Offer food and small blocks of ice to chew to prevent dehydration and relieve stress. Once the otter is alert, stable, feeding, and grooming, transfer to a larger pen with access to a seawater pool.

Washing removes natural oils from the fur and greatly increases thermal conductance. Placing sea otters in seawater pools for brief intervals after cleaning encourages grooming and restoration of the fur's water repellency. The otters must be removed and dried but will gradually tolerate longer periods in the water without chilling. The fur should regain its insulative properties after 7 to 10 days, although restoring full water repellency may require several weeks.

9.7.3. Chemical Restraint[69,79]

Sea otters require chemical restraint for most procedures, including radiographs and ultrasound, thorough examination of the fore-body, administration of fluids by stomach tube, and for any potentially painful procedure or prolonged (>2 to 3 hours) period of immobilization. To prevent regurgitation, withhold food for 1 to 2 hours prior to sedation[71]. Drug selection must consider the potential for disrupting thermoregulation (e.g., as observed with ketamine) or aggravating lung damage, as may occur with inhalant anesthetics. After administering the drug, allow the animal to rest in a cool, dark area until sedation is achieved. **Monitor body temperature of sedated animals frequently.** Once the procedure is completed, continue observations and provide thermal assistance until recovery from sedation is apparent. Make sure the animal is fully recovered before placing it in the pool.

Chemical restraint is not recommended for otters that are unconscious, severely lethargic, or hypothermic and must be performed only by qualified personnel.

9.8. RELEASE

9.8.1. General Criteria[73]

A sea otter should be released only when there is reasonable expectation that it will survive and lead a normal life and will not endanger the health of the wild population. The candidate must be clinically healthy and well nourished; able to swim, dive, and groom adequately; and presumed capable of foraging successfully. Clinical evaluation should include screening for pathogens. Retaining frozen serum (3 ml) from samples collected after admission and pre-release is valuable for retrospective studies of infectious disease. In the U.S., individuals that do not meet these criteria must either be adopted into a captive colony or euthanized; sea otters kept longer than 2 years and orphans not raised for release are considered non-releasable. Pups that are older than 3 or 4 months when orphaned appear to have better chances of post-release survival.

9.8.2. Immediate Release[19]

An animal that is "rescued" but appears healthy and alert and exhibits normal behavior should be released as quickly as possible, at or near the "home" site, unless hazards (e.g., fishing activities, pollution) warrant an alternate location. Do not return dependent pups to the water unless the mother is present. Animals captured far outside the normal range are not candidates for immediate (i.e., on-site) release. Whether released from a boat or on the beach, allow the otters to enter the water of their own accord.

9.8.3. Release Following Recovery[19,73]

As soon as an animal is judged fit, it should be released, either directly into the water[57] or after a period of acclimation in a floating pen where visual and physical contact with humans is minimal. In the U.S., the FWS authorizes sea otter releases. The area of release is preferably within 30 to 80 km of the capture site. If this is not an option (e.g., after an oil spill with persistent contamination of large areas), release the otter within the range of the appropriate subpopulation.

9.8.4. Tagging and Monitoring[41,56]

Tagging (i.e., with visual tags or transmitters) is the only reliable method of monitoring released animals. At a minimum, released otters should be marked with brightly colored plastic flipper tags and, ideally, with an implanted transponder chip. Flipper tags are often lost, but uniquely coded transponder chips (often injected under the skin in the groin area) allow permanent identification if the animal is recovered[65]. Similarly, radio transmitters attached to flippers have allowed brief tracking, but the transmitter is too easily removed by the otter and may damage the flipper. Implanted transmitters are the most dependable means of tagging sea otters for frequent, long-term monitoring.

9.9. EUTHANASIA

In the U.S., the FWS has authorized sea otter rehabilitation centers to euthanize terminally ill animals. This is achieved by injecting a lethal substance into the distal third of the femoral vein, or into the heart or jugular vein[78].

Notes:

Chapter 10
Specimen and Data Collection

10.1. GENERAL CONSIDERATIONS

The primary goal of the investigation is to determine the cause of death or stranding and collect as much biological data as possible. Information gained over time will help scientists and resource managers develop baselines for biology and health, recognize trends and their possible relationships to various environmental factors, and gain knowledge necessary for improved species and habitat management. The emphasis and effort in any investigation will depend on the nature of the event and available resources.

Many protocols have been developed for marine mammal necropsy and sample collection—some for taxonomic groups (e.g., cetaceans[37,51,60] or pinnipeds[30,34]) or species of concern (e.g., northern right whale[63], killer whale[82], Hawaiian monk seal[109], Florida manatee[18,88], and the dugong[33]), and others for cases involving human interaction[42,50,83]. The protocols in this chapter provide a practical approach for most networks conducting routine data and sample collection. Unusual mortality events may require a more rigorous investigation[37] with an expert team. Use of standardized necropsy protocols (ideally, group- or species-specific) is important to facilitate comparison of data among stocks or populations. Screening for specific pathogens (e.g., *Brucella*, CDV, *Leptospira*, and *Toxoplasma*) is of increasing importance for assessing population health and the presence of potential zoonoses (*see* **12.2**); in some cases, negative results are as meaningful as positive cases.

For complicated procedures beyond the experience of the stranding team, one can test the resolve of the investigator requesting tissues by requiring the person to join you on the beach, provide all of the required collection equipment and supplies, and do the work themselves.

10.1.1. Quality of Information

The quality of information obtained from stranded animals depends on a number of factors, including:

- condition and location of specimens
- site safety and access
- size, skills, organization, interests, experience, and morale of the team
- adherence to clear, detailed protocols
- availability of equipment and supplies
- number of animals to be examined
- amount of time available (e.g., available light, tide schedule, etc.)
- care in packaging and labeling samples
- care in shipping and storing samples
- access to a suitable diagnostic laboratory and good working relationships with pathologists experienced in marine mammals diseases.

Information has scientific value only when carefully documented. Persons recording data need reasonable language skills, legible writing, and familiarity with appropriate terminology. Use standardized data sheets or a bound log-book made of good quality paper (waterproof is ideal), and take notes using waterproof ink or soft pencil. Depending on conditions, data collection may be basic (**Level A** [*see* Appendix B: NMFS Level A Data form]), intermediate (**Level B**), or detailed (**Level C**) (Box 10.1).

Beyond written observations, **photographic** and **video-taped records** can bring to life such details as color pattern, distinctive markings, scars or injuries, and the pattern of a mass stranding that may provide clues only after careful scrutiny. Ideally, include photographs showing dorsal, lateral, and ventral (include genital region) views, and with the mouth open to expose teeth or baleen. At minimum, attempt a full lateral view of cetaceans and a dorsal view of pinnipeds. For species included in **photo catalogues**, take additional pictures of **identifying characteristics** (e.g., scars on manatees, flukes of humpback whales, callosity patterns on right whales, and the dorsal fin of dolphins). Make every effort to carefully photograph **human-related injuries**[25,42,50] (*see* Appendix D: *Protocol for Evaluating Marine Mammals for Signs of Human Interaction*). Photographs should **include a reference scale** of known standard size (e.g., ruler, coin) and a label with the field number, date, and location. Keep a record of the photographs taken (for film cameras, include roll and frame number). Scan for PIT (passive integrated transponder) tags, as appropriate (e.g., Florida manatees).

Rare animals require extra effort to ensure complete collection of data. Consider preparing the entire carcass for transport to a suitable laboratory or museum for analysis and preservation of tissues for future study.

Box 10.1. Data Collection

Level A Data: Basic Minimum Data (*see* Appendix B)

1. Investigator: name and address (institution).
2. Reporting source.
3. Species.
   - preliminary identification (by qualified personnel)
   - voucher (supporting) material (photographs; specimens, including mandibles with canines from pinnipeds; entire skulls, mandibles with teeth, tooth counts of odontocetes; or 2 pieces of mid-row baleen from mysticetes)
4. Field number.
5. Number of animals, including total and sub-groups (if applicable).
6. Location.
   - preliminary description (local designation)
   - latitude and longitude (to 0.1 minute, if possible) with closest named cartographic feature as determined subsequently in the lab (GPS units are recommended)
7. Date (mm\dd\yy), time of first discovery **and** of data and specimen recovery.
8. Length (girth and weight when possible) (*see* **10.7**).
9. Condition (recorded for both discovery and recovery times).
   Codes (*see* **10.3**) as follows:
   1) alive
   2) freshly dead
   3) decomposed, but organs basically intact
   4) advanced decomposition (i.e., organs not recognizable, carcass intact)
   5) mummified or skeletal remains only
10. Sex (*see* Figs. 5.1, 6.1, 8.1, 9.1).

(*continued*)

10.1.2. Human Health and Safety: A Reminder

Dead and decaying marine mammal tissues harbor potentially harmful organisms (*see* **12.1**, **12.2**). The risk of infection can be reduced by wearing protective clothing (overalls and rubber gloves—a double layer of surgical gloves is preferred[37]) and eye and face protection (face masks and safety or sun glasses), and by handling tissues carefully. Protect open wounds and avoid contact with fluids or airborne droplets. Keep disinfectant solutions at hand, and when the work is completed ensure participants thoroughly wash their hands. Necropsy of large whales is complex, dangerous, and better left to an experienced team[60,63].

Notify appropriate local and government agencies (*see* **2.6.2**, **2.7.2**) immediately if there is evidence of risk to public health, such as suspected infectious disease, harmful algal blooms, or toxic spills. Local medical or veterinary schools can be good sources of expertise on zoonoses. Provide designated containers for disposal of needles, scalpels, knives, and glass; and keep harmful substances such as formalin in unbreakable containers. Bury or otherwise dispose of the carcass in a

Box 10.1. Data Collection (*continued*)

Level B Data: Supplementary On-Site Information

1. Weather and tide conditions.
2. Offshore human/predator activity.
3. Presence of prey species.
4. Behavior.
   - pre-stranding (e.g., milling, directional swimming)
   - stranding (e.g., determined effort to strand, passive, thrashing)
   - after return to sea (e.g., disoriented swimming, listing); note also tag # and color; location of sighting
5. Samples collected for life history studies (*see* **10.8**).
   - teeth, claws, ear plugs, or bone for age determination
   - reproductive tracts
   - stomach contents
6. Samples collected for blood studies (*see* **10.2**, **10.6**).
7. Disposition of carcass (*see* Chap. 11).

Level C Data: Necropsy Examination

1. Necropsy (*see* **10.4**).
   - collection of tissues for toxicology (*see* **10.9**)
   - collection of samples for microbiology (*see* **10.10**)
   - collection of tissues for gross pathology and histopathology (*see* **10.11**)
   - collection of parasites (*see* **10.12**)

manner that protects the health of the public, local wildlife, and the environment (*see* Chap. 11); in the U.S., contact with regional network coordinators may be necessary. Once the work is completed, remove all materials and equipment from the beach, ideally leaving the site safer than you found it.

10.1.3. Routine Necropsies vs. Unusual Mortality Event Investigation

The cause of an unusual mortality event (*see* **2.7** for criteria and response guidelines) is often unknown at the outset of the investigation. Samples for histopathology, microbiology, molecular diagnostics, and biotoxin and contaminant analyses normally take priority. Efforts may include collecting environmental data and samples (Box 10.5, p. 227) in addition to those collected from dead and live animals. In the U.S., federal agencies may step in to coordinate the investigation (*see* **2.7.3**) and assure that samples are sent to designated analytical laboratories[106]. The local or regional team must respond to any changes in on-site operations, team structure, and priorities associated with such events. In some regions of the U.S., the National Marine Fisheries Service (NMFS) may also designate special teams to investigate large whale strandings[60].

10.2. SAMPLING LIVE ANIMALS

Living animals are designated as **Code 1** specimens (*see* Box 10.1 and **10.3.3**). Photograph anatomical or other distinguishing features that will help identify the species or individual. Photograph all lesions; include a scale in all photos. Skin scrapings, swabs for microbiology and molecular studies, and blood samples are often easily obtained from living animals (Fig. 10.1-10.5), as are parasites from the skin, mouth, and upper respiratory tract (Fig. 10.25-10.30). Portable ultrasound units can provide a noninvasive means to evaluate blubber thickness[64]. A hand-held blood analyzer can allow rapid evaluation of hematology and serum chemistry[20].

Blood can also be used to detect exposure to **contaminants** or **biotoxins**[89,101]. Collect at least 1 mL of blood in a heparinized syringe or vacutainer. Separate the serum and freeze at -20°C for shipment, or refrigerate and ship using cold packs. **Blubber** biopsies from healthy animals are also useful for contaminant analysis[67] and may be suitable for banking[14] (*see* **10.9**).

Blood and **epidermis** (biopsies or sloughed skin) are good sources of **DNA** for genetic analyses[31,43,110] (*see* **10.8.2**). Epidermis also may be requested for other purposes, including tissue cultures, isotope analyses, and molecular studies[58].

Anyone taking blood samples, biopsies, or performing other medical procedures must comply with all state/provincial, regional, and federal veterinary regulations.

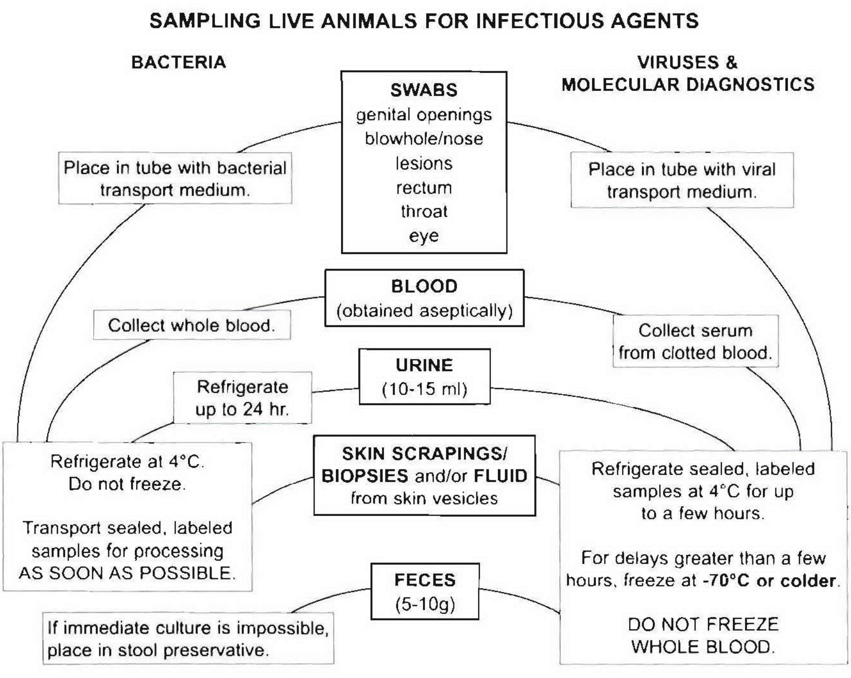


Fig. 10.1. Sampling live animals for infectious agents.

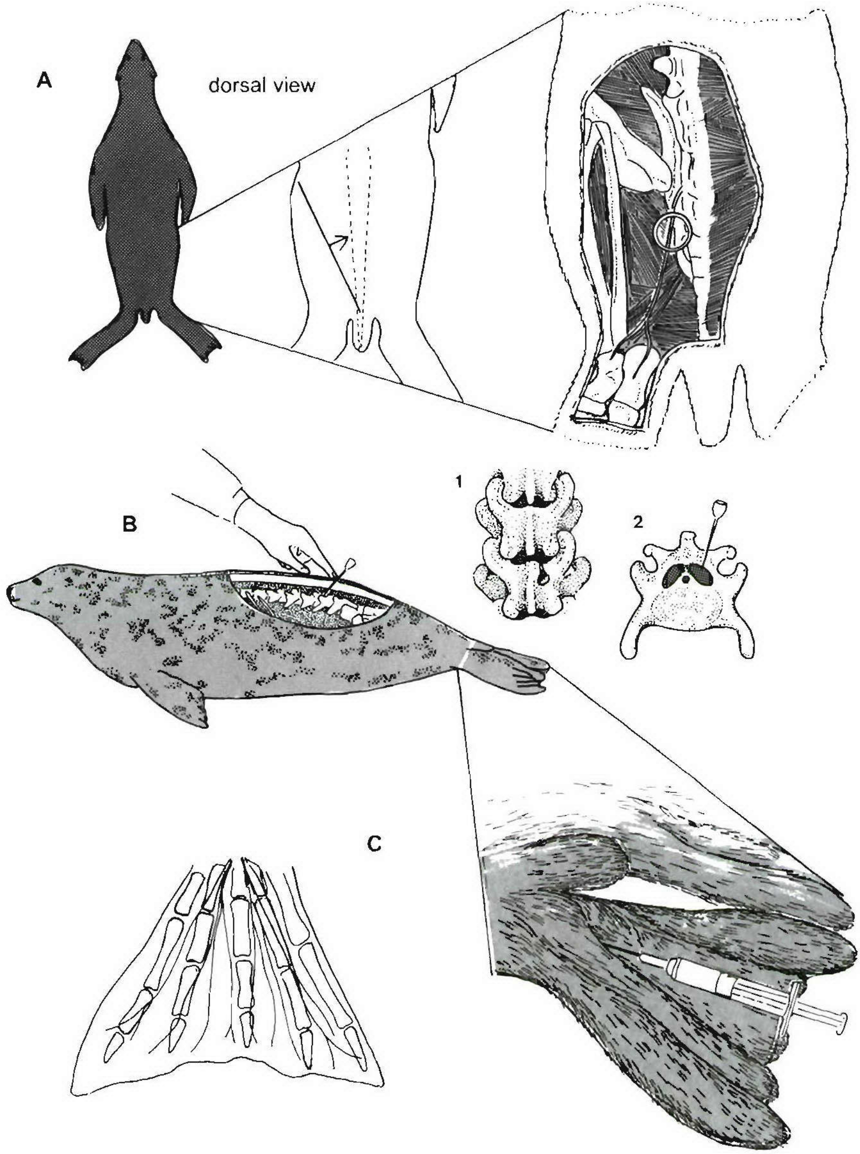


Fig. 10.2. Pinniped blood sampling. **A.** Blood sampling from the caudal gluteal vein of otariids. The needle (20-gauge, 4-cm; 18-gauge for large animals) is inserted at a point along the pelvic bone approximately perpendicular to the midpoint of a line from knee to base of tail. **B.** Extradural blood sampling technique for phocids and otariids. The index finger is used as a guide for inserting the needle between the dorsal spinous processes (**1**) of the lumbar vertebrae and into the bilaterally divided extradural vein (**2**), which overlies the spinal cord. **C.** Blood sampling from the hind flipper of a seal. The needle is inserted into the rich vascular network in the metatarsal region, just above the origin of the interdigital webbing on the plantar surface. Physical restraint is generally adequate to obtain a blood sample (*see* **5.5.4**). More fractious animals may require sedation or anesthesia.

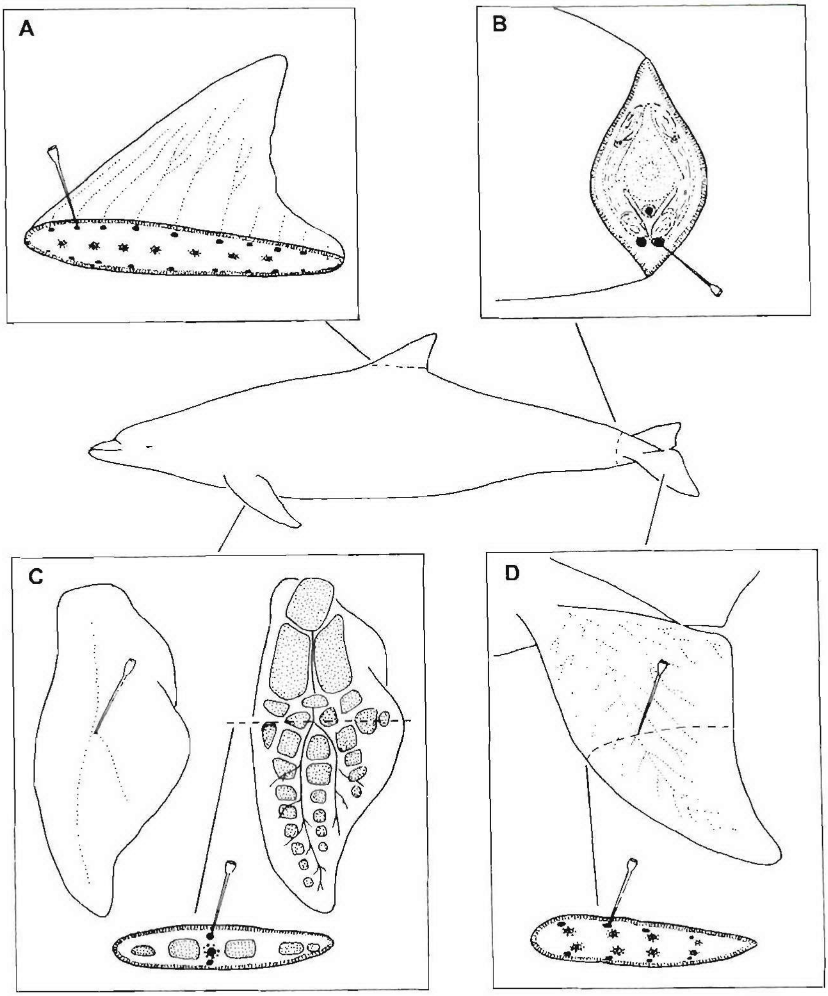


Fig. 10.3. Cetacean blood sampling. **A.** Dorsal fin. **B.** Caudal peduncle. **C.** Pectoral flipper. **D.** Flukes. Sampling is carried out at all sites, on small to large cetaceans, using an 18-gauge 4-cm needle. Needle bore should be scaled down for calves and the very small Dall's and harbor porpoises.

(continued)

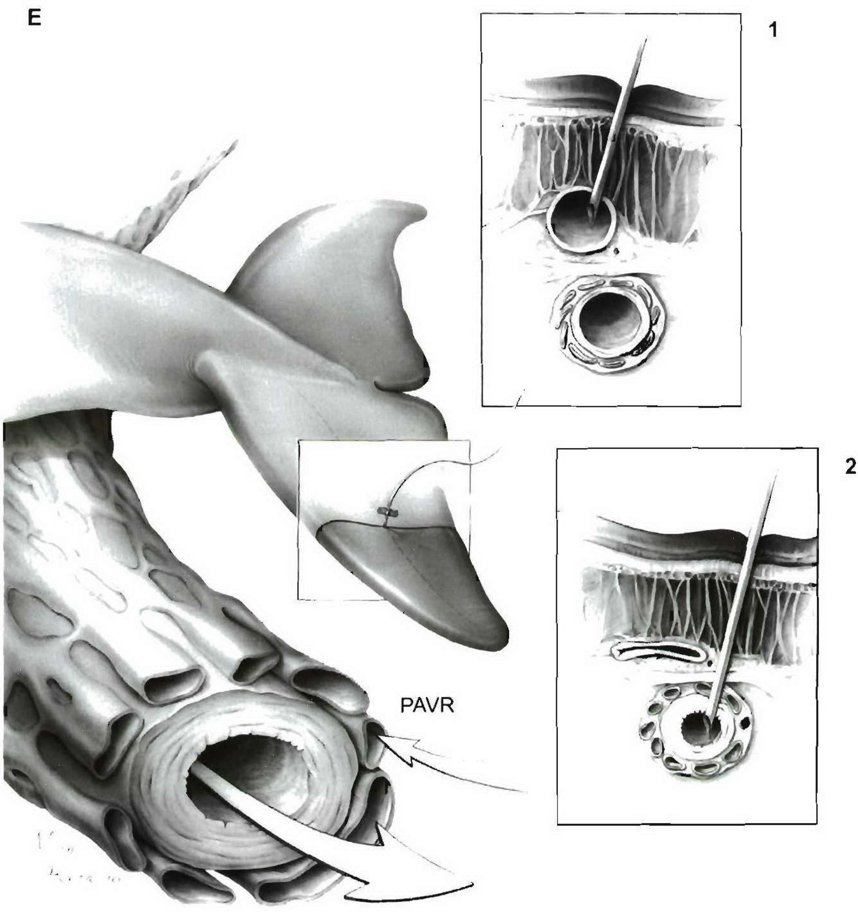


Fig. 10.3. Cetacean blood sampling (*continued*). **E.** Blood sampling from the flukes. **1.** When taking blood under warm conditions, insert the needle into a superficial vein, evident as a ridge along the dorsal surface. **2.** Under cold conditions, when venous blood is returned through the periarterial venous rete (PAVR), insert the needle deeper to strike the artery or the PAVR. Use of an extension set between the needle hub and vacutainer minimizes injury to animal or handler and insures continuous flow if the animal moves. (Illustration © A. Hoofring, Baltimore, MD.)

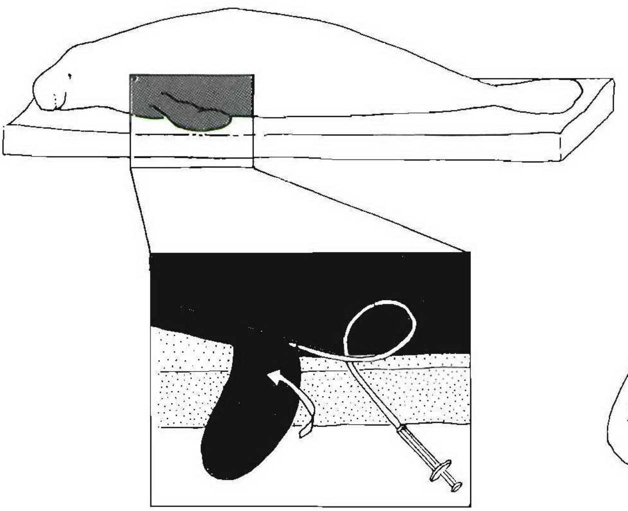


Fig. 10.4. Manatee blood sampling. A needle (18-20 gauge, 2.5-4 cm) with an extension tube is inserted into the palmar[103] or lateral[86] side of the forelimb between the radius and ulna.

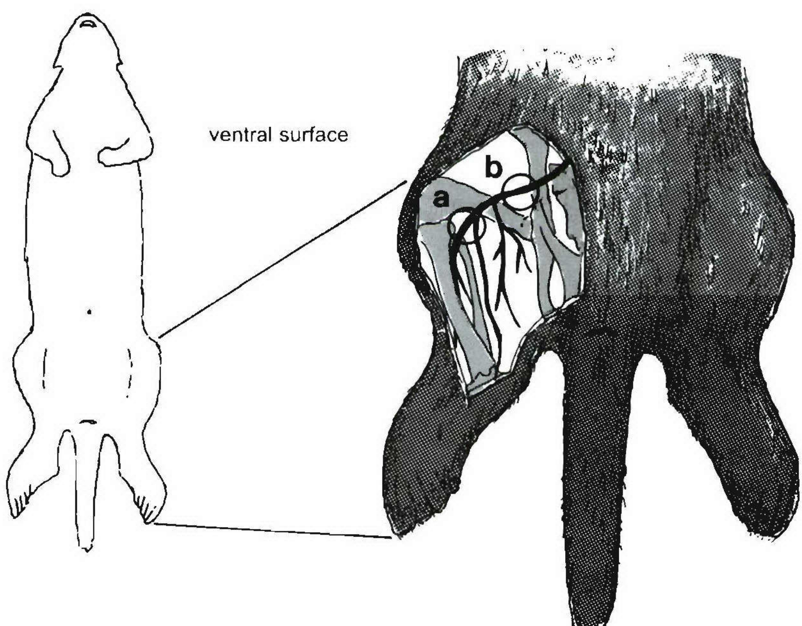


Fig. 10.5. Sea otter blood sampling. Blood is drawn from the (**a**) popliteal vein about 1 cm posterior to the femoral condyles[61] or (**b**) from the proximal third of the femoral vein (or from the jugular vein if the animal is under anesthesia) using a 20-gauge, 2.5-cm needle (adapted from Williams 1990[107]).

10.3. EVALUATING A CARCASS

Before obtaining tissue samples from dead animals, evaluate the quality of the carcass and its suitability for the intended study.

10.3.1. External Features

The condition of a carcass cannot be evaluated solely by its outward appearance or estimated time since death. The rate of decomposition is proportional to body temperature: larger, rotund carcasses retain heat longer than smaller, thin ones. Cetaceans (except sperm whales and the Balaenidae) sink after death, then float days or weeks later when buoyed by decomposition gases, and arrive ashore outwardly unchanged but internally decomposed. At the other extreme, seagulls may begin gouging the eyes and penetrating the skin and blubber of the jaw and body openings of a living dolphin, perhaps already mutilated by shells and rocks during stranding. By the time the animal dies, the carcass may already appear to be spoiled. A dead harp seal, buoyant with thick winter blubber, may float ashore as soon as it dies. In summer, or after illness, leaner carcasses come ashore only after they sink and refloat.

In small pinnipeds, **rigor mortis**, the stiffening of the body muscles, can be a useful index of time since death. The process begins within hours after death, varying with the animal's terminal condition and the ambient temperature. The duration is also variable but is measured in hours or, under cool conditions, perhaps a day or two. **The presence of rigor mortis indicates a carcass in moderately good condition (Code 2).** Muscle stiffness may be a less reliable indicator of time since death in polar waters, where carcasses tend to remain firm for a longer period.

Skin, eyes, and exposed mucous membranes dry rapidly after death and are not an accurate gauge of quality of a carcass out of water. These tissues retain their vital appearance longer in water or with humidity or precipitation and then, too, may be unreliable indicators.

Bloating is generally a sign that a carcass is not fresh (**Code 3**), though some diseases may cause gas production in tissues even in live animals. Tell-tale signs of decomposition include a protruding tongue and penis and tension or tightness of the skin. At some point the gases escape, and it may not be obvious whether the process has just begun or ended.

The only reliable approach is to examine the carcass internally.

10.3.2. Internal Features

The **blubber** of a fresh carcass is firm, mostly white, and only moderately oily. With time, it may become tinged with blood (imbibition) from underlying tissues. Eventually, the oil begins to separate (delipidation) and pool, leaving behind a lacework of greasy connective tissue fibers.

Fresh **muscle** is dark (except in neonates and manatees) and firm, and the bundles are distinguishable and easily separated. As a carcass decomposes, the muscles become soft, first black then pale, translucent, and pasty; fiber bundles become almost indistinguishable.

The **rate of decomposition** may be increased by the animal's terminal condition, such as a generalized infection with increased body temperature (fever) or rapid bacterial invasion. Because blood and enzymes promote the process, decomposition is rapid in the brain, spleen, liver, kidney, adrenal glands, and gastrointestinal tract, and slower in skin, blubber, and muscle. The process is slower also in animals that bleed to death and in carcasses that have been cut open and exposed to cold water.

10.3.3. Carcass Classification

Despite the difficulty in determining the stage of decomposition, a system is needed to define the quality of the material and, thus, the appropriate strategy for sample collection. The following is an expanded version of the code system established by the Smithsonian Institution's Marine Mammal Events Program (formerly the Scientific Event Alert Network). Animals or carcasses are assigned to one of five basic categories, determined by specific characteristics (*see* Box 10.1, Level A Data).

CODE 1: Live Animals

Useful for: morphometrics, biopsies (e.g., for cell culture lines), blood studies (e.g., hematology, serology, immune function, clinical chemistry, reproductive hormone status, nutritional analyses), DNA analysis, and toxicology; limited life history, external gross pathology, parasitology, and microbiology.

CODE 2: Carcass in Good Condition (Fresh)

Useful for: morphometrics, DNA analysis, possible sampling to establish cell culture lines, life history, parasitology, gross pathology and histopathology, toxicology, microbiology, molecular studies (e.g., polymerase chain reaction [PCR]), and nutritional analyses (trace minerals and vitamins A and E); limited blood studies (i.e., heart blood for serology).

Characteristics: normal appearance, usually with little scavenger damage; fresh odor; minimal drying and wrinkling of skin, eyes, or mucous membranes; eyes clear; carcass not bloated, tongue and penis not protruded; blubber firm, white, and semi-translucent; muscles firm, dark red, well-defined; blood cells intact, able to settle in a sample tube; serum unhemolyzed; viscera intact and well-defined (liver is a good indicator); gut contains little or no gas (sirenians excepted); brain firm with no discoloration, surface features distinct, easily removed intact.

CODE 3: Fair (Decomposed, but organs basically intact)

Useful for: morphometrics, DNA analysis, parasitology, gross pathology, histopathology (particularly of skin, blubber, muscle, lung, and firm lesions), molecular studies (e.g., PCR); limited life history; marginal for toxicology (useful for metals and some biotoxins, marginal for organochlorines).

Characteristics: carcass intact, bloating evident (tongue and penis protruded) and skin cracked and sloughing; possible scavenger damage; characteristic mild odor; mucous membranes dry, eyes sunken or missing; blubber blood-tinged and oily; muscles soft and poorly defined; blood hemolyzed, uniformly dark red; viscera soft, friable, mottled, but still intact; gut distended by gas; brain soft, surface features distinct, dark reddish cast, fragile but can usually be removed intact.

CODE 4: Poor (Advanced decomposition)

Useful for: morphometrics, heavy metal analysis; limited life history (teeth, baleen, bone, claws, some stomach contents, possibly reproductive condition), DNA analysis, parasitology, and gross pathology.

Characteristics: carcass may be intact, but collapsed; skin sloughing; epidermis of cetaceans may be entirely missing; often severe scavenger damage; strong odor; blubber soft, often with pockets of gas and pooled oil; muscles nearly liquefied and easily torn, falling easily off bones; blood thin and black; viscera often identifiable but friable, easily torn and difficult to dissect; gut gas-filled; brain dark red, pudding-like consistency, and with gas pockets.

CODE 5: Mummified or Skeletal Remains

Useful for: morphometrics; limited life history (teeth, baleen, claws, bone), gender in some species, and DNA analysis.

Characteristics: skin may be draped over skeletal remains; any remaining tissues are desiccated.

10.4. PROTOCOLS—GENERAL CONSIDERATIONS

First, ensure that the size and the experience of the team and the resources available are sufficient for the task at hand. Avoid the impulse to collect specimens that may be of marginal or no value. **Follow clear protocols, and confirm beforehand the range of samples required and the most up-to-date protocols for collecting, packaging, and shipping.** Advanced techniques for pathogen identification are encouraging collection of samples for molecular studies and bacteriology even from autolyzed carcasses. Develop cooperative agreements with researchers who are doing work that interests you. Forging such agreements beforehand will allow a more streamlined collection of data and tissues on site. In a mass stranding, concentrate first on the freshest specimens, not necessarily the most convenient,

and perform the procedures as soon as possible. Avoid contaminating tissues with dirty instruments or body fluids. Mark carcasses with colored ribbons, tags, or spray paint to indicate the stage of protocol completion (*see* **7.7**).

Plan thoughtfully. **Include the carcass's identification number with every sample collected and on each page or item of documentation** (e.g., necropsy forms, photos). Obtain morphometric data first, then photographs or video, followed by external examination, documentation of any abnormalities, then sample collection (genetics, microbiology, toxicology, histopathology). Once the carcass is opened, gross observations, photodocumentation, and data recording take precedence, followed by collection of samples for microbiology and molecular studies; tissues may then be collected for histopathology, parasitology, toxicology, life history, and ancillary diagnostics (Table 10.1). This order follows the sequence of general dissection and examination (*see* **10.5**). If a fresh carcass must be frozen for later necropsy, first collect blood samples for serology (*see* **10.6**).

10.5. EXAMINING THE CARCASS[18,30,34,37,51,63,89,109]

Procedures for dissecting and examining carcasses vary with the size and species of animal, associated circumstances (e.g., carcass location and environmental conditions), and investigators' preference. The following outline, condensed from specific protocols and personal experience, is one way to carry out a systematic examination of a carcass. Before beginning, record the animal's ID number on each page of a full set of data sheets and sample information cards and tags; insert a label card with ID into each sample bag and container for histopathology. Complete all sections of the necropsy form to minimize incomplete examinations or misinterpretations (i.e., no abnormalities observed *vs.* not examined).

1. **IDENTIFY** the species and determine the sex (Figs. 5.1, 6.1, 8.1, 9.1). **DESCRIBE** and **PHOTOGRAPH** form, color pattern, scars, other distinguishing features (e.g., number and position of teeth or characteristics of baleen), injuries, external lesions, etc.; for populations included in photo catalogues, photograph pertinent characteristics (e.g., callosities of right whales, both sides of the dorsal fin of coastal dolphins). **Include a scale** in all photos. Tooth counts (*see* Chap. 15) are taken from one side of the upper and lower jaw.

2. Take **MEASUREMENTS** (*see* **10.7**, Figs. 10.6-10.8, 10.13), including blubber thickness (Fig. 10.9; note if epidermis is included). Note signs of skin sloughing or blubber delipidation. Collect skin samples for genetics. Obtain body **WEIGHT** if possible. The body weight of cetaceans can be estimated based on heart weight (without blood): $\log W = (\log H + 2.2)/0.984$, where H = heart weight and W = body weight, in kg[91]. (*See also* Figs. 5.2, 6.3 for help with estimating weights.) Note method used for estimate.

Table 10.1. Sample Selection and Preservation Methods

TISSUE	PRESERVATION METHODS					
	[1]10% NB formalin	[2]Chill at 4°C	[3]Freeze	70% EtOH	[4]AFA	Other
Skin/Epidermis	**histo**	bact	[5]genetics		**para**	[5]**genetics**
Blubber	histo		**tox**-org, biotox		para	
Blood		**bact**	tox, biotox, **virol, serology**			[6]**hematol, clin chem,** genetics
Muscle	histo		tox-inorg		para	
Thyroid	**histo**					
Thymus	histo		virol, molec studies			
Tonsils	**histo**					
Heart	**histo**	**bact**	[5]genetics		**para**	[5]genetics, cell culture
Pericardial fluid		bact	**virol**, serology			cytology
Lung	**histo**, biotox	**bact**	**virol**, **PCR**, biotox		**para**	
Pleural fluid		**bact**	**virol**			cytology
Upper resp. tract	histo, biotox	bact	**PCR**		**para**	swab for **PCR** (CDV, *Mycoplasma*)
Lymph nodes	**histo**	**bact**	**virol, PCR**			
Peritoneal fluid		**bact**	**virol**			cytology, [6]clin chem
Adrenal	**histo**	bact	virol, PCR			
Liver	**histo**, biotox	**bact**	**virol**, **tox**-org-inorg, biotox, vit A&E		**para**	[5]genetics
Bile		bact	tox-P, biotox			
Pancreas	histo				**para**	
Kidney	**histo**		**tox**-inorg, biotox, **virol**		**para**	
Bladder	histo		virol (CDV)			
Urine		**bact**	biotox, **virol**			urinalysis
Repro. tract	**histo**, **life hist**	**bact**			**para**	
Placental/Fetal	**histo, life hist**	**bact**	**virol, tox**		**para**	[5]genetics
Mammary	histo	bact			**para**	
Milk		bact	tox, nutrit studies			smear for para
Stomach	**histo**	bact/fungal			**para**	
Stomach contents			tox-P, biotox, **diet**	**diet**	**para**	examine for toxic algae
Intestine	**histo**	bact	virol, EM, tox		**para**	
Spleen	**histo**	**bact**	**virol, PCR**			
Brain/CNS	**histo**, biotox	bact	**virol**, **PCR**		**para**	
Teeth		aging	aging	**aging**		[7]aging, ID
Baleen						[7]**aging**, **ID**
Earbones	histo, **aging**			aging		acoustic trauma
Ear plugs	aging		PCR (*Mycoplasma*)	**aging**		
Bone	aging	**bact**	aging	aging		[7]aging
Feces	para	**bact**, **para**	biotox		**para**	[8]bact

(continued)

Table 10.1 (*continued*)

Preservation methods:

1. Fix samples for histopathology (~3 x <1 cm) in 10% neutral buffered (NB) formalin (1 part tissue: 10 parts formalin); place small minced subsamples of selected lesions in 3% glutaraldehyde for EM study. (*See* **10.11**.)
2. Refrigerate (4°C) samples for bacterial (6-cm cubes) or fungal culture for transport to laboratory. (Do not use dry ice.) Place swabs for bacterial culture in bacterial transport medium. (*See* **10.10**.)
3. Refrigerate (4°C) samples for up to a few hours. If analysis is delayed, freeze (-70°C or colder preferred for samples for serology [*see* **10.6**]; organic [tox-org] contaminants and petroleum hydrocarbons [tox-P]; and virology and PCR [*see* **10.10**]). Place swabs for virology and PCR in viral transport medium (or consult with specialists prior to collection).
4. Examine for parasites (para): fix digeneans (i.e., trematodes), cestodes, and acanthocephalans in AFA (alcohol-formalin-acetic acid); nematodes in 10% glycerin in 70% alcohol (or AFA); ectoparasites in 5% glycerin in 70% ethanol; and samples of associated lesions in 10% formalin. (*See* **10.12**.)
5. Preserve slivers of tissue up to 2 cm long in saturated NaCl in 20% DMSO (or freeze sample). Skin samples for DNA analysis should include junction of epidermis and dermis.
6. For hematology use EDTA tubes; for clinical chemistry use serum separation (or heparin) or EGTA tubes (*see* **10.6.2**); for DNA studies use tubes with anticoagulant (EDTA or citrate, not heparin); for biotoxin analysis use tubes with heparin. **As a rule, refrigerate whole blood, freeze serum or plasma at -70°C or colder.**
7. Clean and dry (then refrigerate or freeze baleen).
8. Place 5 to 10 g of feces in stool preservative.

Note: Basic samples are shown in bold.

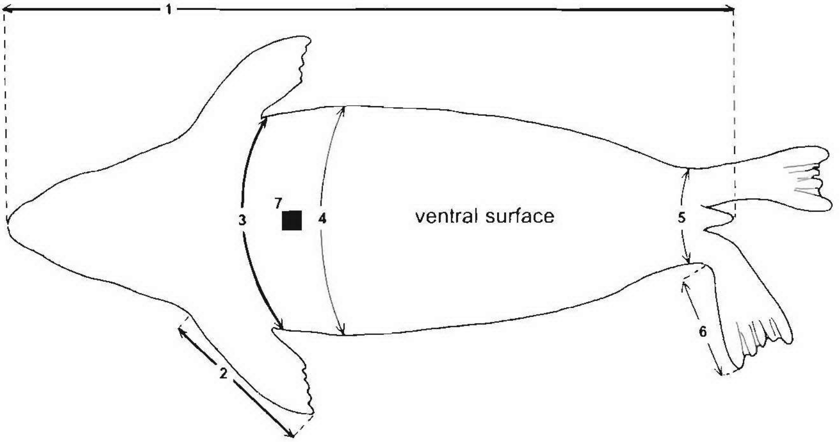


Fig. 10.6. Measuring pinnipeds. **1.** Standard length, from tip of snout to tip of tail. **2.** Anterior length of foreflipper. **3.** Girth: axillary. **4.** Girth: maximum (specify location). **5.** Girth: at the level of the anus. **6.** Anterior length of hind flipper. **7.** Blubber thickness over posterior end of sternum (Note: site may vary with species or group). **As a minimum, measure 1, 2, 3, and 7.** (Modified from Scheffer 1967[92] and Winchell 1990[109].)

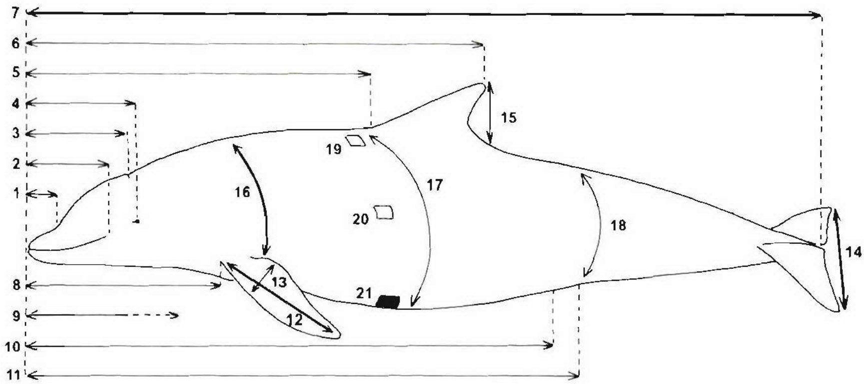


Fig. 10.7. Measuring cetaceans. **1.** Snout to melon. **2.** Snout to angle of mouth. **3.** Snout to blowhole. **4.** Snout to center of eye. **5.** Snout to anterior insertion of dorsal fin. **6.** Snout to tip of dorsal fin. **7.** Snout to fluke notch. **8.** Snout to anterior insertion of flipper. **9.** Snout to caudal end of ventral grooves (when present). **10.** Snout to center of genital aperture. **11.** Snout to center of anus. **12.** Flipper length. **13.** Flipper width (maximum). **14.** Fluke width. **15.** Dorsal fin height. **16.** Girth: axillary. **17.** Girth: maximum (specify location). **18.** Girth: at level of anus. **19.** Blubber thickness: dorsal (anterior and lateral to dorsal fin). **20.** Blubber thickness: lateral at mid-length. **21.** Blubber thickness: ventral at mid-length. **As a minimum, measure 7, 12, 14, 16, and 21.** (Modified from Norris 1961[68].)

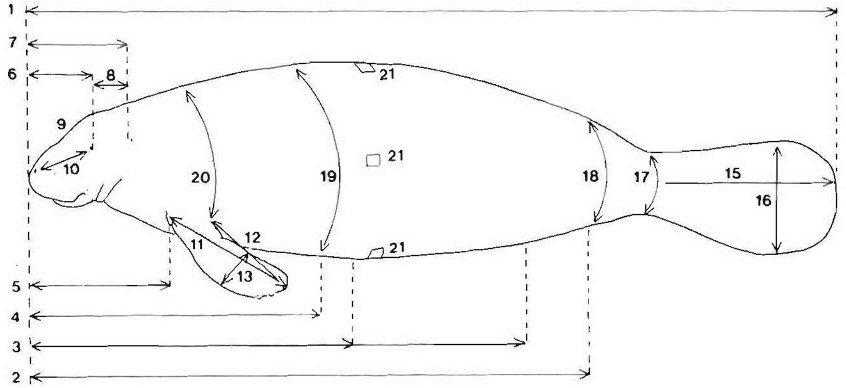


Fig. 10.8. Measuring manatees. **1.** Tip of snout to tip of fluke. **2.** Tip of snout to center of anus. **3.** Tip of snout to center of genital aperture. **4.** Tip of snout to center of umbilicus. **5.** Tip of snout to anterior insertion of flipper. **6.** Tip of snout to center of eye. **7.** Tip of snout to external ear. **8.** Center of eye to ear. **9.** Distance between centers of eyes. **10.** Center of eye to center of nostril (same side). **11.** Flipper length, anterior insertion to tip. **12.** Flipper length, axilla to tip. **13.** Maximum width of flipper. **14.** Perpendicular length of teat, right and left (*see* Fig. 8.1 for location). **15.** Base of fluke to posterior tip. **16.** Maximum width of fluke. **17.** Girth at fluke base. **18.** Girth at anus. **19.** Girth at umbilicus. **20.** Girth at axilla. **21.** Thickness of skin: dorsal, lateral, ventral. **Thickness of blubber**—Outer: dorsal, lateral, ventral. Inner: dorsal, lateral, ventral. Girths and flipper lengths recorded on fresh animals (**Code 2**) only. (Adapted from Bonde et al. 1983[18].)

3. Conduct the **EXTERNAL EXAMINATION** (Fig. 10.10). Note general condition (e.g., emaciation); describe and illustrate scars, lesions, parasites, and discharges. Take samples as appropriate (Table 10.1). Check for evidence of **HUMAN-RELATED INJURY** (Box 10.3, p. 215) (e.g., propeller scars, entanglement, missing flippers or fins, deep puncture wounds, lesions encircling the flippers or flukes)[42,50,83]. Distinguish "crush" wounds from "high velocity" wounds (e.g., bullets, propellers); the latter may show shattering and scattering of bone fragments along the wound tracks. Distinguish between a gunshot wound and any other by locating the bullet; take samples from along the projectile path (preserve in 10% NB [neutral buffered] formalin) to help determine (by histological examination) whether the injury occurred before or after death. A metal detector or radiographs (lateral and ventrodorsal views) may facilitate localization and recovery of bullets. In cases of vessel strike, hull paint may be collected from skin barnacles for chemical characterization[81]. Look for **TAGS** or tag scars (i.e., tear in rear flipper or dorsal fin).

   Examine the **UMBILICUS** of neonates. Examine the **MAMMARY GLANDS**; attempt to express milk, note color and consistency, make smears for examination for parasite ova and larvae, and collect samples for toxicology. In odontocetes, extend the **PENIS** from its sheath; examine the surface and soft tissues at the base for small cauliflower-like lesions or ulcerations.

4. Examine the **MOUTH** and **TEETH/BALEEN**; note parasites or abnormalities (e.g., worn or broken teeth, fractured or abraded baleen, gum and tongue condition, or obstructions). For cetaceans, note number and position of teeth and degree of tooth wear or, for baleen whales, the number, color, and length of the longest baleen plates (Fig. 10.16). Check the **BLOWHOLE/NASAL PASSAGES** for parasites, discharges, or obstructions; make smears for parasitologic examination and obtain swabs for bacterial culture and molecular diagnostics (*see* **10.12**). Examine the **EYES** for clarity, surface lesions, injuries, and discharges. Conjunctival scrapings may be obtained for molecular studies, electron microscopy (EM), and virus culture. In cases of suspected metabolic disease or impaired renal function (e.g., leptospirosis), eye fluid (vitreous) may be aspirated and submitted for clinical chemistry[81]. Collect external swabs for microbiology (by incising the lesion with a sterile scalpel) before opening the carcass.

5. Open the carcass for **INTERNAL EXAMINATION**, preferably on or abutting a plastic or Teflon sheet. (In cetaceans, a section of skin and blubber can serve as a small work surface.) Have all instruments, collecting jars and bags, labels, camera, and preservatives on hand before making the first incision. For pinnipeds, manatees, and sea otters (Figs. 10.11-10.13), position the carcass on its back; make a mid-line incision through skin, blubber, and muscle from jaw to anus without penetrating the abdominal cavity. Fold back the skin and

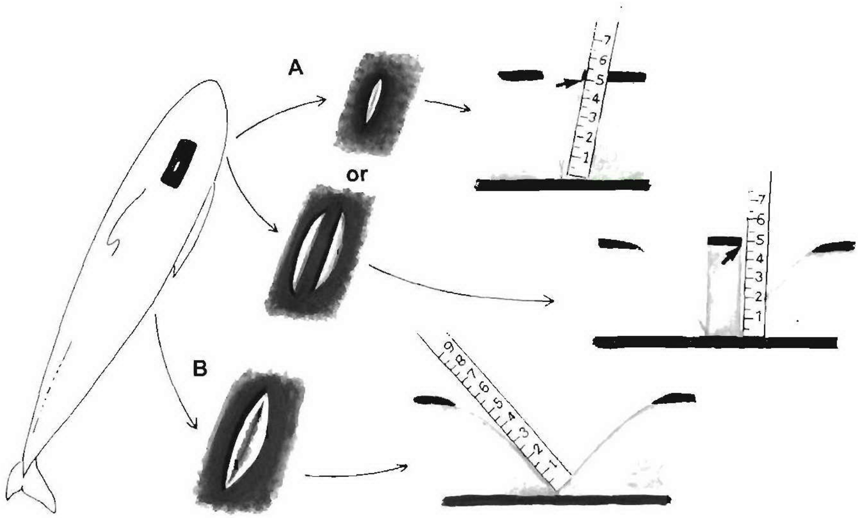


Fig. 10.9. Measuring blubber thickness. **A.** To minimize distortion, measure within a short incision or measure the column of blubber between two longer incisions. **B.** A long incision results in distortion of the blubber and inaccurate measurements.

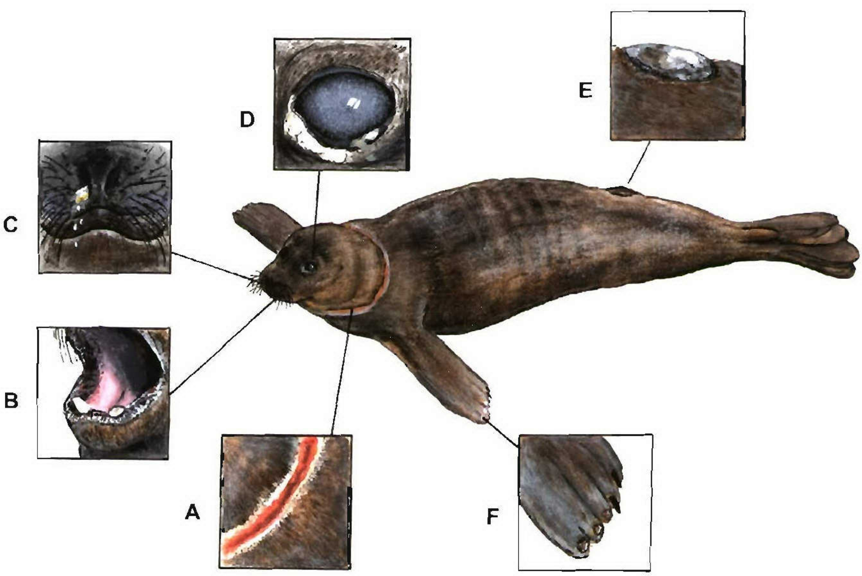


Fig. 10.10. The external examination: examples of external pathologic conditions. **A.** Circumferential laceration, neck. **B.** Broken (fractured) tooth. **C.** Unilateral nasal discharge. **D.** 1) Corneal opacity, diffuse. 2) Ocular (conjunctival) discharge. **E.** Oval, hairless, smooth gray nodule (give dimensions). **F.** Three missing claws; possible nail-bed inflammation.

blubber from each side; remove or deflect the forelimbs, including the scapula. Be prepared to remove a flipper or claws for age determination. Position a cetacean carcass on its side, preferably left side up. Remove blubber and skin to the level of the skeletal muscle along the lateral body wall (Fig. 10.14).

Note: Use clean equipment and gloves to collect samples. **At each stage of the examination, sample tissue as soon as it is exposed.** Note organ position, texture, and color and any noticeable smells. Using Table 10.1 as a guide, **first take samples for toxicology** (*see* **10.9**; Figs. 10.17-10.19), **microbiology, and molecular diagnostics** (*see* **10.10**; Figs. 10.21, 10.22). **Be prepared to describe, photograph, and remove tissues for histopathology** (*see* **10.11**; Figs. 10.23, 10.24). **Collect duplicate samples** when possible—one for analysis, the other for archiving. **Search specific anatomic locations** (Figs. 10.25-10.30) **for parasites** (*see* **10.12**). Immediately **package and label samples**, including the date, log number, species, and tissue.

6. Examine the **BLUBBER** or **SUBCUTANEOUS FAT** (the latter will be depleted in animals in poor nutritional condition); note any abnormalities; sample for toxicology and histopathology. Dissect the **MAMMARY GLANDS**; examine the ducts for nematodes (cetaceans); take a ~3 x 1-cm-thick slice about halfway along the length for histopathology and an additional sample for bacterial culture. Obtain a milk sample for contaminant and possible nutritional analysis. Examine the superficial **FASCIA** (cetaceans) for nematode tracts (white, noodle-like structures). Note **MUSCLE** color, texture, symmetry, concavity or convexity, and any abnormalities. If vessel strike or other human-related impact injury is suspected, remove as much skin and blubber as possible; examine the musculature for hemorrhage and other lesions[63] such as crush injury and fractured ribs (*see also* #14).

7. Before opening the **THORACIC CAVITY**, incise the diaphragm and assess for negative pressure. Open the thoracic cavity (pinnipeds, sea otters, and manatees) by cutting the rib cage along the sides at the junctions of the ribs and the costal cartilages (Fig. 10.11); then remove the sternum and attached cartilages. In cetaceans, cut the articulations between the ribs and sternum, and between the ribs and vertebrae (cranial ribs have double articulations along the back) (Fig. 10.14). Attempt to disarticulate rather than cut the ribs; the former may be easier on a large cetacean (moving the rib with one hand while cutting with the other may help). (Large baleen whales often float in on their backs; a ventral midline incision along the small cartilaginous joints of the sternum will separate the thorax, and the whale's weight will help open the carcass.) **Cover the tips of fractured or cut bones to prevent personal injury.** In some animals, a chain, reciprocating, or hack saw may be necessary to cut through and remove ribs. Examine the thoracic cavity with organs in place; note abnormalities (e.g., discolorations, excess fluids, lesions, adhesions). Examine the **PLEURA** and

DIAPHRAGM. Note size, color, location, and consistency of the **THYMUS** in young animals. Assess the volume and sample the **PERICARDIAL FLUID** with a sterile syringe before opening the pericardium, or introduce a swab through a small incision. In pinnipeds, examine and sample the mediastinal lymph nodes, located along the central midline in the mid-thoracic cavity.

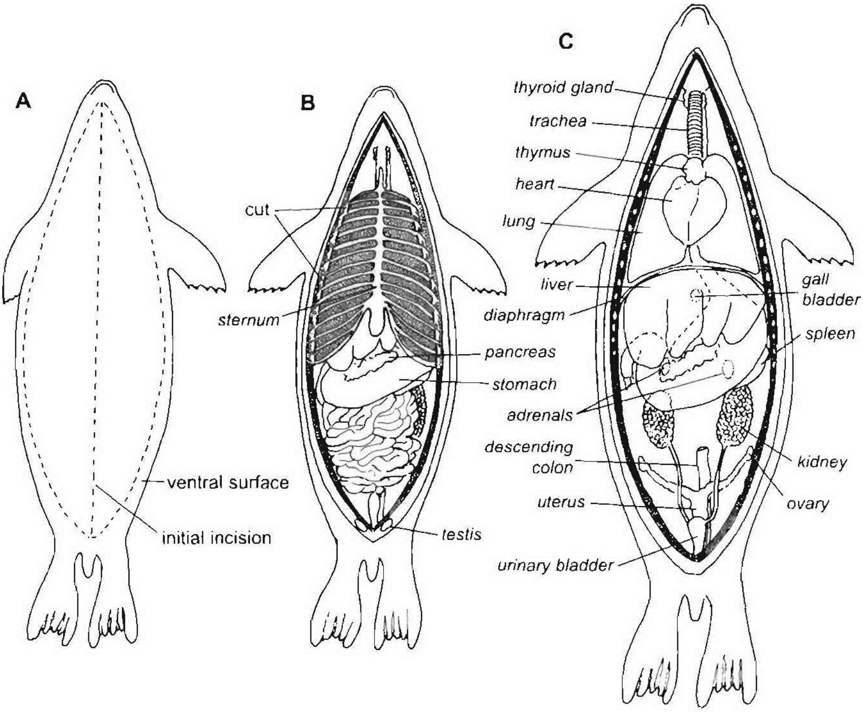
A. In small animals (not manatees) remove the **PLUCK** (heart, lungs, trachea, esophagus, larynx, and tongue) intact by cutting the tongue from the lower jaw and pulling it backward, severing connective tissue attachments and hyoid bones. Note any congestion or hemorrhages in the muscles of the thoracic inlet. Place the pluck on a clean surface, dorsal side up, for dissection.

B. Incise the dorsal oropharyngeal mucosa; collect the **TONSILS** for histopathology and, if indicated, other diagnostic studies. Remove and examine the **SALIVARY** and **THYROID GLANDS**. Note size, shape, and consistency.

C. Open and examine the entire length of the **ESOPHAGUS**; check for ulcers, obstructions, and parasites. In cetaceans, the **LARYNGEAL TUBE** is now exposed for examination. Assess the laryngeal mucosa for evidence of hemorrhage, which may be indicative of acoustic trauma (*see* Box 10.4, p. 216), and the lumen for foreign bodies or evidence of inflammation.

D. Open the entire length of the **TRACHEA** and along the **BRONCHI**; dissect through to the small airways, deep within the lung parenchyma. Note characteristics of airway fluid (i.e., clear, frothy, hemorrhagic). Quantify and collect any parasites present. Describe and sample areas that stand out in marked contrast to the main body of tissue. Aspirate fluid and save sample in a clean tube to check for the presence of sea water. Examine the **LUNGS** for color, consistency, texture, and presence of parasites, aspirated ingesta, froth, water, or other fluid; sample for microbiology, molecular studies, parasitology, and histopathology. Note the condition of the bronchial lymph nodes. In cetaceans, examine both lung-associated lymph nodes and sample for histopathology, microbiology, and molecular studies. In cetaceans, assess the fat deposits along the caudal lobes of the lung; sample for histopathology.

E. Examine the **HEART** in situ; if manageable, remove for further evaluation. Note color and quantity of pericardial fluid and amount of coronary fat. Examine the coronary vasculature for evidence of abnormalities, then heart tissue for paler areas, fibrosis, hemorrhage, or other abnormalities. Sample blood from the right or left ventricle. Open the heart following the course of the circulation—from right atrium to ventricle into pulmonary artery, and left atrium to ventricle into aorta; note thickness of the walls and



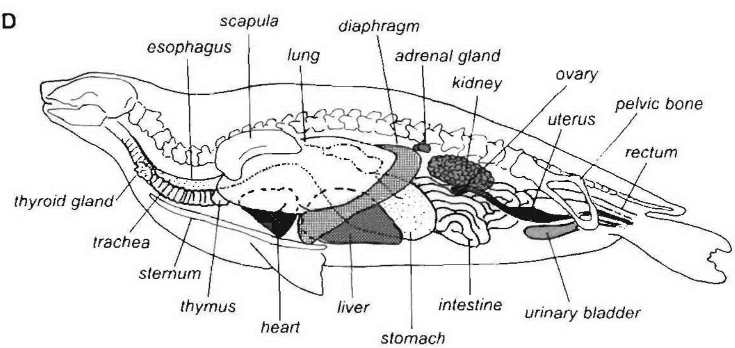


Fig. 10.11. Pinniped dissection and internal anatomy. **A.** Initial incisions. **B.** Ventral view of superficial viscera before removal of sternum and costal cartilages. **C.** Ventral view of major internal organs after removal of intestines (modified from Fay et al. 1979[34] and Winchell 1990[109]). **D.** Lateral view of major internal organs of a phocid seal (modified from Rommel[87]).

irregularities of valve leaflets. In young animals, assess the chambers for congenital anomalies or defects. Check for nematodes (seals and cetaceans) and evidence of bacterial endocarditis. Note presence and nature of clots.

8. To expose the **ABDOMINAL VISCERA**, incise the abdominal musculature along the caudal margin of the ribs and dorsal limit of the abdominal cavity and reflect downwards; avoid puncturing the intestines. Examine with organs in place, noting color, consistency, orientation, and grossly apparent abnormalities (e.g., fluids, lesions, adhesions, or displacement). Examine the **MESENTERIES** and **MESENTERIC LYMPH NODES**. In neonates, assess the internal and external aspects of the umbilicus and connections to the liver and bladder. Check for cestode cysts in the abdominal cavity and blubber of cetaceans (Fig. 10.27). In fresh carcasses with suspected noise-related injuries (e.g., sonar-related), examine the vasculature of intestines, intestinal mesentery, liver, and kidneys for intravascular gas bubbles and photograph any suspected abnormalities[36,47].

    A. Move the stomach and intestines aside and, using the kidneys as landmarks, locate, remove, and examine the **ADRENAL GLANDS**. Incise and visually examine for any abnormalities; sample for microbiology; package each gland (or portion of each) separately in 10% NB formalin and label, including "right" or "left."

    B. Remove and examine the **SPLEEN**; note size, texture, and character of cut surfaces. Examine the peritoneum and abdominal cavity. Carefully remove the **GASTROINTESTINAL TRACT** and associated organs, first tying off the stomach near the base of the esophagus (not necessary with manatees) and at the distal limit of the colon. Spread the GI tract on a clean surface (away from the carcass) for examination. Remove and examine the **PANCREAS**; cut a series of parallel, transverse incisions ("bread loaf"); note the degree of scarring or fibrosis in cetaceans; dissect open the **HEPATOPANCREATIC DUCT** (in cetaceans) and check for digeneans (i.e., trematodes), gall stones, masses, or other abnormalities. Dissect the gut free from the mesentery. Examine the **STOMACH** surface for perforations. With small animals, collect the stomach and contents and freeze for later evaluation, or incise and drain the contents into a plastic bag or bucket (*see* **10.8**). Alternatively, cut small openings into the stomach to visually evaluate the mucosa and obtain samples for histopathology. Note any ulcerations, foreign objects, or parasites, both free and embedded in the mucosa. Examine the external surfaces of the **INTESTINES** for nodules, perforations, segmented discoloration, or adhesions. Open and examine the gut for abnormalities, including hemorrhage, character of the mucosa, parasites, and obstructions; describe and sample the contents. Note the texture of the **OMENTUM** and **MESENTERIES**; note the amount of fat; and check for acanthocephalan parasites (spiny-headed worms) (none in manatees).

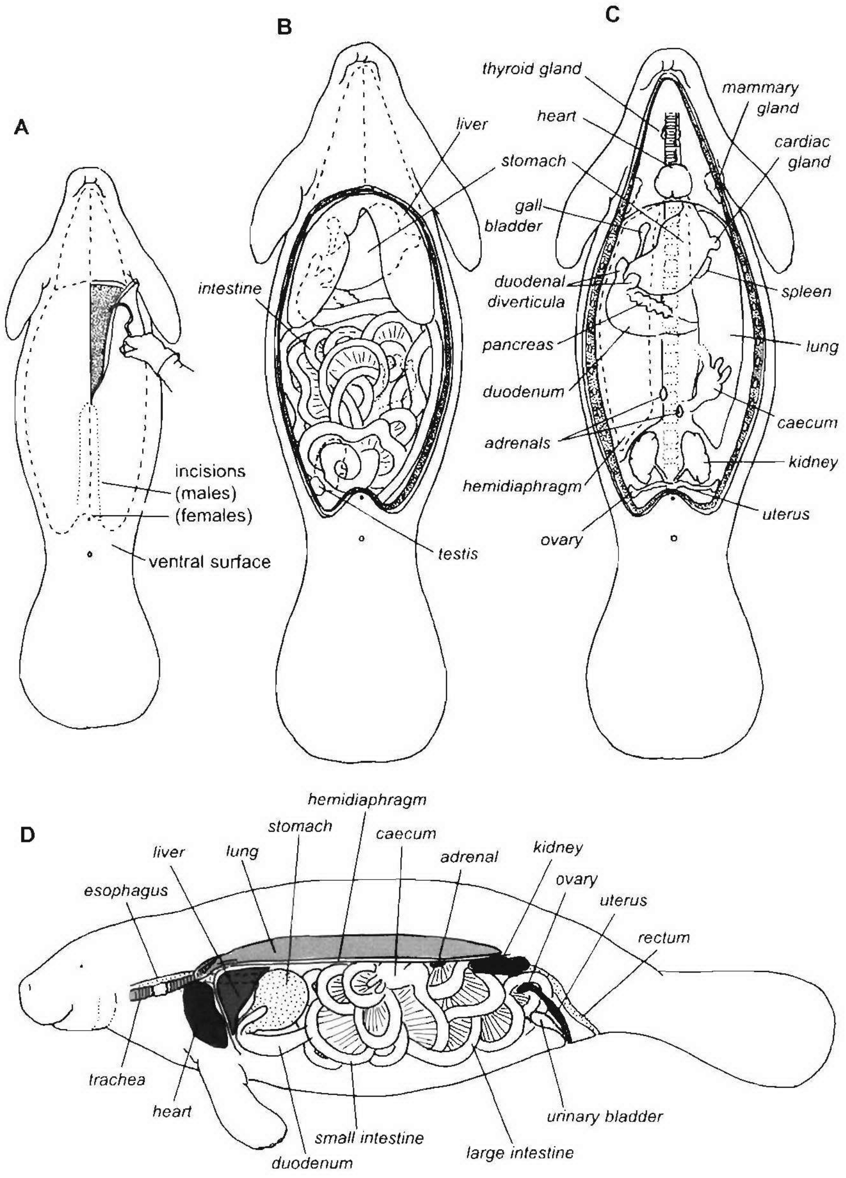


Fig. 10.12. Manatee dissection and internal anatomy. **A.** Incisions for manatee dissection. **B.** Major internal organs before opening of pericardial cavity. **C.** Major internal organs after removal of liver, intestines, and left hemidiaphragm. **D.** Lateral view of major internal organs. (Redrawn and modified from Bonde et al. 1983[18].)

C. Remove and examine the **LIVER**, noting surface texture and color, character of margins (sharp or rounded), and adherence of the serosa to the parenchema. Serially slice all lobes and examine the internal appearance. Open the **GALL BLADDER** (none in cetaceans); note the character of bile (e.g., thickened, fluid, sludge) and **BILE DUCTS**; examine for digeneans. Use a syringe to collect a bile sample from the duct (before it is opened); protect bile samples from light and freeze as soon as possible.

D. Examine the **KIDNEYS** for abnormalities; remove by cutting the peritoneal attachments. Serially slice the entire length or width of the kidney and examine for abnormalities, such as stones, cysts, and (in large whales and beaked whales) parasitic nematodes. Examine the **URETERS** and **BLADDER**. Assess the degree of bladder distention and, before incising, aspirate urine with a syringe and needle (in males urine can be collected from the penis by squeezing the bladder); check and record color, consistency, and approximate volume; save for later analysis. Open the bladder and check for abnormalities in the lining or in contents (e.g., stones). In large whales and beaked whales, examine the blood vessels and urinary ducts for nematodes or obstructions.

E. Assess reproductive status, then remove and examine the reproductive tract; note abnormalities. Record the weight, length, and sex of any fetus. Collect the fetus and placenta; collect samples of fetal tissues for bacteriology, toxicology, nutritional analysis, and molecular studies; and fix a complete set of tissues in 10% NB formalin. Examine both ovaries for corpora lutea (or preserve whole for later examination) and weigh; if present, take care to locate the fetus or collect the entire reproductive tract. Examine, measure, and weigh the uterus; open and examine. (In sperm whales, check the uterus and placenta for large nematodes.) Remove the testes, epididymides, accessory sex glands, and penis; examine, measure (length, width, greatest circumference) and weigh the testes separately. Prepare a slide smear to check for the presence of sperm. Package the gonads individually (or 1 cm-thick sections from large testes, one cross and one longitudinal) and label "left" or "right" (freeze or fix in 10% NB formalin). (Examination for and counting of corpora albicantia and corpora lutea, and checking the epididymis for sperm are best done in the laboratory. In dolphins, urine also may contain microscopic evidence of sperm.) For endangered species, consider chilling and forwarding individual testes to a reference laboratory for attempted sperm recovery and cryopreservation.

9. To collect or examine the **SKULL**, disarticulate the head between the skull and the first cervical vertebra; secure a tag for identification (Fig. 10.14). Remove and examine the **EYES**. With suspected noise-related strandings, assess the fatty tissue behind the eyes for hemorrhage and sample for histopathology[81].

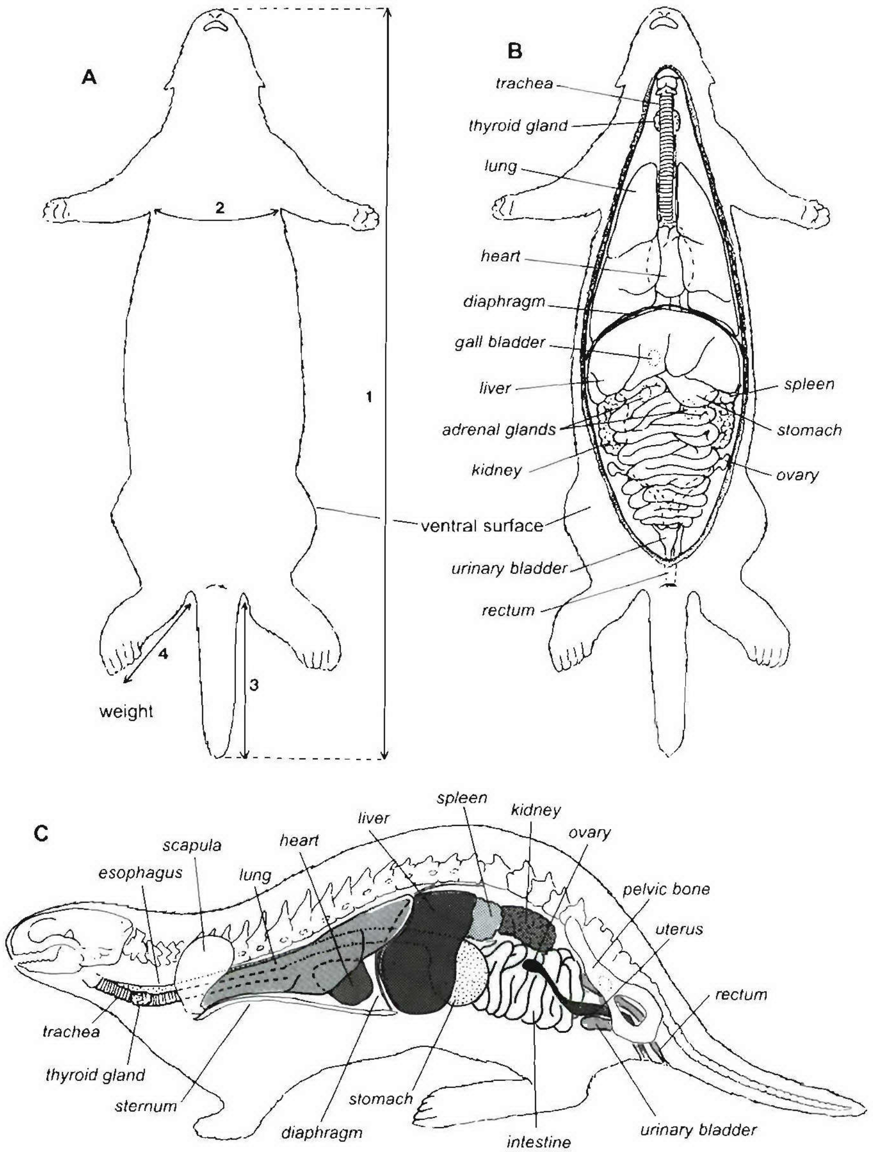


Fig. 10.13. Sea otter measurement and internal anatomy. **A.** Measurements. **1.** Total length from snout to tip of tail. **2.** Axillary girth. **3.** Length of tail. **4.** Length of foot. **B.** Ventral view of major internal organs (redrawn and modified from Stoskopf and Herbert 1990[97]). **C.** Lateral view of major internal organs (adapted from Barabash-Nikiforov et al. 1947[8] and Stoskopf and Herbert 1990[97]).

In cetaceans, open the **BLOWHOLE AND NASAL PASSAGES**; sample for histopathology, molecular diagnostics (e.g., PCR for *Mycoplasma*[81]), and bacterial culture; check for parasites (Fig. 10.27).

10. Examine the **MIDDLE EAR** and **PTERYGOID SINUSES** of cetaceans for parasites by placing the head upside down and dissecting away the lower jaw. Take time and care to free all tissue attachments at the angle of the jaw (forcing open the mandible will crush the tympanic bones). Cut away soft tissue to expose the entrance to the pterygoid sinus; use a bone cutter to dissect deep into this cavity. Rinsing sinuses with saline or water will help flush out concealed nematodes and digeneans. Carefully remove the ear bones (tympanoperiotic complex in cetaceans) and place in 10% NB formalin or 70% ethanol for histological studies[49]; for aging studies, freeze or fix in formalin or ethanol. If high pressure injury (blast/acoustic trauma) is suspected, arrange for immediate expert consultation and examination (*see* Box 10.4, p. 216).

11. In fresh carcasses of baleen whales, collect the **WAX PLUG** at the proximal end of the auditory canal[71]; handle carefully and place it in a rigid container with 10% NB formalin for aging studies.

12. To expose the **BRAIN** (useful only in **Code 2** specimens), remove the top of the skull (difficult for manatees) and cut away the soft tissues over the cranial vault. (Fig. 10.15 shows an approach for cetaceans.) This procedure requires a handsaw, hammer and chisels, and for larger animals, a sturdy meat-hook or pry-bar. Examine the exposed brain for color, consistency, lesions, and evidence of inflammation. Remove by cutting away the thick meningeal casing. Collect samples for contaminant and biotoxin analysis, molecular studies (e.g., PCR), and microbiology, as appropriate. Fix remainder for histology by slicing every 1-2 cm, with some cuts extending deep enough into the cortices for the preservative to reach ventricles; place in 10% NB formalin. (Some protocols request the brain be collected intact and fixed for two weeks prior to shipment or sampling, changing the formalin after one week[84].) Alternatively, if the foramen (opening between the brain and spinal cord) is sufficiently large, samples of cerebellum and cerebral hemispheres can be removed and preserved as above. A portion of **SPINAL CORD** may be taken from the cervical and thoraco-lumbar regions for molecular studies, bacterial culture, and histopathology; and cerebrospinal fluid collected with a syringe for cytology, bacterial culture, and possible serology. *See* Box 10.4 for sample collection in cases with suspected trauma due to noise exposure.

13. Sample **TEETH** for **AGE DETERMINATION**. In odontocetes, they may be extracted from the mandible by cutting down into the gum on either side of the tooth row and prying out at least 6-8 midrow teeth; or use a saw to take a section of the mid-mandible with teeth in place for later extraction (Fig. 10.14).

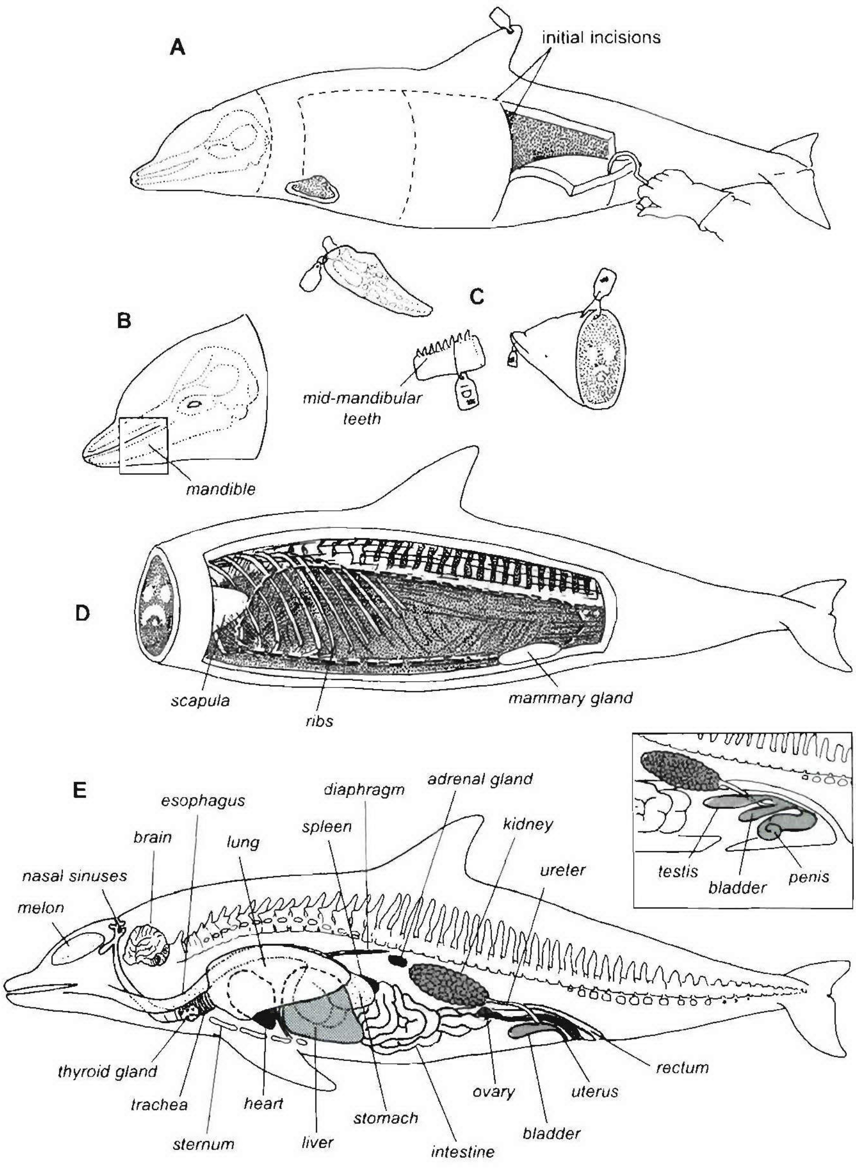


Fig. 10.14. Cetacean dissection and internal anatomy. **A.** Initial incisions for removal of skin and blubber. **B.** Site of mandibular tooth collection for age determination. **C.** Labeled voucher specimens and samples for age determination. **D.** Opening in lateral body wall in relation to skeletal structure. **E.** Lateral view of major internal organs, female and (inset) male (adapted from Rommel 1990[87]).

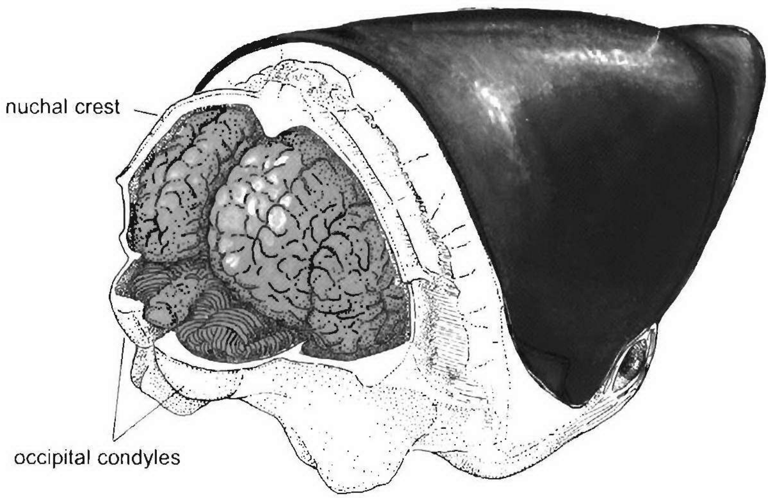


Fig. 10.15. Removing the cetacean brain. Make two horizontal cuts, one through the occipital condyles and the other posterior to the nuchal crest. Join these laterally with two vertical cuts. A chisel may be needed to break the bony septum that separates the hemispheres. Remove the bony plate to expose the brain; tilt the skull backwards while sliding a hand over the surface of the hemispheres to sever soft tissue connections to the dura and cranial nerves.

Canines and the first 3-4 postcanines (incisors and premolars) (or section of the skull or mandible containing them) are recommended for pinnipeds; take lower canines from walruses[38,44]. Collect the lower first premolar (if not possible, the upper) of sea otters[16]. For practical reasons, the entire lower jaw may be removed and frozen for subsequent tooth aging. Teeth are not useful for age determination of manatees (collect the ear bone instead). (*See* Table 10.2.)

14. Examine the entire skeleton (as feasible) for evidence of recent fractures, inflammation, irregularities, healed injuries, or other pathology. This is especially important in cases of suspected human-related injury.

10.6. BLOOD STUDIES

10.6.1. Rationale

Blood samples provide insights into the health status of the animal and offer one approach to determining what processes might have been responsible for or associated with the stranding event[20,104]. A broad spectrum of analyses can be performed that identify bacterial, viral, parasitic, toxicologic, metabolic, and traumatic conditions.

Animal/Carcass selection: Code 1 ideal; **2** limited; 3, 4, 5 useless.

Blood samples have value for hematology and clinical chemistry only when taken from live animals, or within minutes after death, and when collected and handled properly[20,59]. **Samples collected from animals dead for more than a few minutes are generally useful only for serological and immunoglobulin quantification studies**[2].

10.6.2. Sampling

Freshly dead animals, including those euthanized by lethal injection, can be sampled in the same manner as live ones (Figs. 10.2-10.5). When procedures are carried out more than a few minutes after death, **samples can be taken from the right ventricle of the heart or vena cavae with a syringe and needle**: 20-30 mL of whole blood is enough to run a comprehensive set of analyses. Five tubes should be ready to receive the blood: **1)** EDTA for hematology; **2)** heparin for harvesting plasma; **3)** a chemically clean tube for separating serum; **4)** EGTA (ethyleneglycol-bis-N4-tetraacetic acid) for catecholamines; and **5)** sodium citrate for glucose and coagulation studies. Additional samples may be desired for DNA studies (*see* **10.2**), vitamin analysis, or toxicology (*see* **10.9**). **Record times of death and sample collection.** Place blood in a cooler or on ice and transport to the laboratory as soon as possible for processing. A blood smear is useful if samples for hematology cannot be analyzed within 24 hours. Serum or plasma (for chemistry) has a longer shelf life than whole blood. The sooner the red cells are removed after sampling, the more credible the results. Frozen whole blood has little or no value for routine hematology and clinical chemistry.

<u>Ideal</u>

Samples are obtained before death, following proper procedures for collection and handling, and analyzed immediately.

<u>Practical</u>

Rarely do situations allow for blood to be taken from a carcass in good enough condition to be of much use for clinical diagnostics. However, viral, bacterial, or parasitic antibodies will persist and can be detected in samples taken many hours or even days after death from **Code 2** animals. Heart blood, even from **Code 3** carcasses, may be useful for pathogen identification using highly sensitive methods such as fluorescent polarization assay (FPA) and enzyme-linked immunosorbent assay (ELISA)[2].

<u>Precautions</u>

Samples are easily contaminated with body fluids. Blood parameters begin to degrade within minutes after death. Red cells rupture if samples are mishandled or frozen, giving erroneous results. Blood samples for toxicology must be collected and handled with particular care to avoid contamination (*see* **10.9**)[78].

10.7. MORPHOMETRICS

10.7.1. Rationale

Morphometric and descriptive data provide basic biological information. When correlated with information on age, stage of maturity, reproductive status, parasite burden, and disease, these data improve our understanding of populations, physiology, and health.

Animal/Carcass selection: Code 2, 3 ideal; **1, 4, 5** limited.

Every carcass provides morphometric data, even skeletal remains. The amount available depends on the state of the carcass.

10.7.2. Measurements

Measurements are taken according to the appropriate protocol for the animal (e.g., Figs. 10.6, 10.7, 10.8, 10.13). The procedure is straightforward, requiring one or two persons with a tape-measure and one to record. **Augment measurements with photographic documentation (include a scale).**

All measurements can be valuable, but standard length is consistently useful. Except for girth and other specified dimensions, **measurements are always taken in a straight line from point to point**, not following the contours of the body. **Standard length** is the straight-line distance from the tip of the snout (or the melon, if more anterior) to the tip of the tail or notch of the flukes. For pinnipeds, the animal must be laid out on its back with the spine and neck straight (the latter may require gently pushing down on the neck). Girth measurements are useful only when there is no evidence of bloating. The girth of large whales is generally recorded as 2 times the measured distance between the mid-ventral and mid-dorsal points on one side of the body; however, these types of measurements can vary. For greater accuracy, measure the entire girth[63]. Estimated measurements or weights must be clearly indicated as such on the data sheet, including the basis for the estimate (e.g., partial measurements, visual assessment). **Blubber thickness** (does not include "skin") is measured from a perpendicular cut (Fig. 10.9); an oblique incision will distort the measured depth. Basic protocols for blubber measurement may include only one or a few sites; species- or group-specific protocols may identify numerous locations to better assess nutritional status and body condition[63,90].

Mysticetes can be identified by the number of **ventral grooves** and characteristics (length, number, and color) of **baleen plates**[108]. Count the grooves on one side of the body, from the mid-ventral groove upward, and double it. Length is measured from the tip of the lower jaw to the end of the longest groove (excluding the mid-ventral) in a straight line parallel to the body axis. Baleen is counted along the outer edge of the series of plates at gum level, as shown in Fig. 10.16; optimally, the number is an average of counts obtained for both sides of the jaw.

Ideal

A complete set of data includes measurements of as many external features as possible, whole body weights, and weights of major organs.

Practical

Rarely are all measurements taken, but even under poor conditions with little time and few resources, it should be possible to obtain standard length, using knots as markers on a rope or string if necessary. Though desirable, weighing carcasses or organs in the field can be unfeasible. For some, it may be possible to divide and weigh the pieces separately. Metric units are preferred, but any system of measurement can be converted later.

Precautions

Adhere strictly to the protocol, measure uniformly, and always from the same specified point (e.g., from the midpoint of the genital slit and not from either end). **Specify the units of measurement used.** In mass strandings, assign one team to take all measurements. Obtaining an accurate standard length of carcasses that are in rigor mortis or frozen, particularly pinnipeds, can be difficult. Wait for rigor mortis to pass or until the carcass is moved to a location where it will thaw.

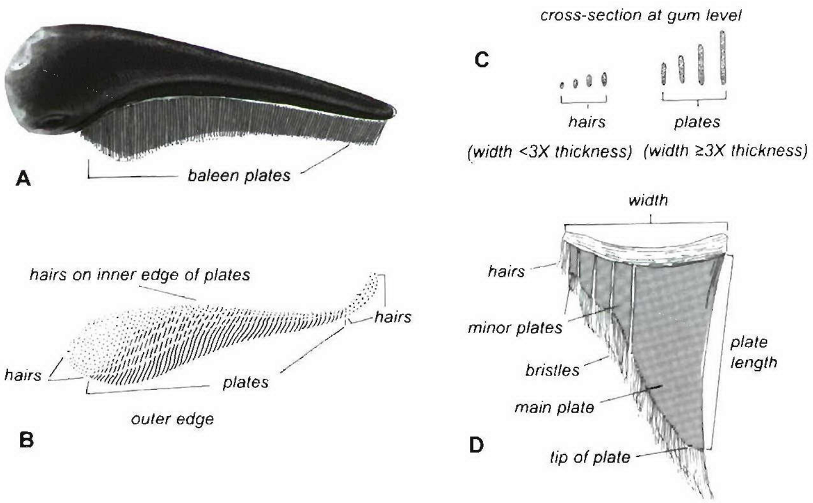


Fig. 10.16. Counting and measuring baleen. **A.** Baleen series extend along each side of upper jaw; plates at front and rear become smaller and less easily distinguished, eventually just hairs. **B.** Simplified view of arrangement (at gum level) of rows of baleen plates (main and minor plates, hairs) and baleen hairs. Counts are taken along the outer edge of the plates. **C.** Examined in cross-section at gum level, baleen plates have a width at least 3X their thickness; those with width less than 3X the thickness are termed hairs. **D.** Typical baleen plate, consisting of main plate along outer edge, one to several minor plates, and hairs along inner margin; bristles extend from plate margins to form filtering network. Plate length is taken as the straight-line distance from the outer edge at gum level to the tip of solid portion of main plate. (Adapted from Williamson 1973[108].)

10.8. LIFE HISTORY AND GENETICS

10.8.1. Rationale

Information on age, genetics, reproductive status, and feeding habits is important for developing conservation and management strategies. Life history information makes data on pathology and toxicology meaningful. In general, biological data are additive: the more we gather, the greater their meaning.

Animal/Carcass selection: Code 1 limited.

Live animals provide information on morphometrics, social organization (i.e., age and sex composition of groups), diet (gastric samples and fecal analysis), and genetics (i.e., DNA from skin or blood); they are also the best source of blood samples for a variety of studies, including reproductive hormone and nutritional analyses.

Code 2, 3 ideal; **4, 5** limited.

Most carcasses provide suitable samples of teeth or skeletal remains for age determination, or tissues for genetic (i.e., DNA) analysis. Only fresh (**Code 2**) baleen whale carcasses yield suitable earplugs. Gonads and uterus can be taken from **Code 2** and possibly **Code 3** carcasses. Stomach contents can be collected from **Code 2**, and some from **Code 3, 4**, and even **Code 5** carcasses (e.g., otoliths and squid beaks).

10.8.2. Sampling

Teeth for age determination can be easily obtained using pliers, and for large mammals, a hammer and chisel (*see* **10.5** #13). In the field, teeth (or sections of skull or mandible) can be held at ambient temperature. To retard soft tissue decomposition, teeth may be placed in 70% ethanol or frozen. Preserve **earbones** for age determination in 10% NB formalin or temporarily in ethanol.

Other bone specimens for aging studies can be frozen, preserved in 10% NB formalin or alcohol, or cleaned and dried without affecting the clarity of the periosteal layers. The sample should include a bone end incorporating a cartilaginous growth plate or a scar of an old growth plate. Removing **earplugs** of baleen whales requires skill and, sometimes, heavy equipment to position the skull[71]. (Earplugs are of limited use for age determination of minke whales[22] and not useful for bowheads[39]). *See* Table 10.2 for a summary.

For **DNA studies**[31,65,89,110], **blood** has value when collected from live or freshly dead animals. **Heart muscle** and **liver** are useful from **Code 2** carcasses. Skin (i.e., epidermis) or bone can be useful years after death. Collect **blood** (at least 10 mL) in a tube with anticoagulant (EDTA or citrate, not heparin). Ideally, centrifuge and transfer the buffy coat to a tube containing SDS (sodium dodecyl sulfate)/urea;

Table 10.2. Specimens for Age Determination

Group/species	Technique	Tissue/specimen	Preservative
Cetaceans			
toothed whales	tooth layers[44,45,74]	6-8 teeth from mid-mandible; or take left mandible	70% ethanol or freeze at -20°C
baleen whales	ear bone layers[22]	ear bones (tympanic bullae)	10% NB formalin, or 70% ethanol, or cleaned and dried
	ear plug layers[53,71]	ear plug	10% NB formalin
	aspartic acid racemization of lens[6,39]	eyes (fresh specimens)	freeze (-20°C)
Pinnipeds	tooth layers[44,96]	canines and post-canines *incisors or post-canines[5,15]	as for cetacean teeth
walrus		lower canine[38]	
Sea otter	tooth layers - cementum[16]	first premolar	as for cetacean teeth
Manatee	ear bone layers[57]	ear bones	10% NB formalin, ethanol temporarily

*Useful for age determination of live animals.

alternatively, refrigerate samples that will be tested within 3 to 4 days and ship using cold packs. If the blood has coagulated, collect clotted material, freeze at -20°C, and transport frozen. Cut **tissue samples** into small pieces (~0.25 x 0.5 x 0.5 cm) and place in a labeled vial with 20% dimethylsulfoxide (DMSO) in saturated NaCl. Soft tissues may also be frozen or preserved in 70 to 85% ethanol (one part sample to 2 to 3 parts preservative). **Do not preserve tissue samples in formalin for DNA analysis.**

For small animals, preserve (in 10% NB formalin) the entire **reproductive tract and organs**; freeze if no fixative is available. In all cases, preserve both ovaries (whole) and a sample of mammary tissue. Measure, weigh, and examine testes and epididymis; preserve in formalin. Slice large testes to ensure proper fixation (or collect 1-cm-thick samples). Collect the baculum (penis bone). Measure, weigh, and determine the sex of the **fetus**. For fetuses, the placenta, lung, and stomach contents should be cultured for bacteria; liver and kidney harvested for trace mineral, vitamin A, and contaminant analysis; and a complete set of tissues collected for histopathology. Thymus, brain, lung, lymph nodes, and spleen may be frozen for virology, molecular (PCR), and other ancillary studies. Serum, feces, and urine can be collected from live animals, and feces and urine from fresh carcasses, for determining **reproductive hormone levels**; freeze samples for shipping[89].

Open the **stomach** carefully by incising along the greater curvature of the stomach, and gently flush the contents with fresh water or saline into a plastic bag or bucket. (Brush contents if sampling for biotoxins; avoid using water[62].) Once samples

are collected for histopathology, scrape the mucosa to obtain embedded, small but diagnostically important otoliths (ear bones of fish). Contents may include recognizable prey species, macerated flesh, skeletal fragments, parasites, and fluid. (In cetaceans, the contents needed for dietary analysis are in the first stomach chamber.) Collect and package the entire stomach contents of small animals, including non-food items. A representative sample may be all that is possible to collect from large animals. Stomach content samples from cetaceans, pinnipeds, and sea otters can be frozen or preserved in 70% ethanol. Preserve stomach contents from manatees in 5% NB formalin[18,88] at a ratio of one part contents to one part preservative. Freeze stomach contents in cases of suspected biotoxin (NSP, PSP) exposure (Table 10.3). Be prepared to remove a subsample (whole fish, macerated flesh) for toxicology, and samples of parasites and lesions to address other protocol requests (*see* **10.9**, **10.11**, **10.12**). Ingesta may also be evaluated cytologically for the presence of phytoplankton.

Ideal

Obtaining complete samples for life history study is a realistic goal when the carcass quality permits. There are usually enough stomach contents to serve multiple protocols.

Practical

A stomach full of food decomposes rapidly, leaving unmanageable foul-smelling fluid. Collecting and weighing stomach contents of large animals is an ordeal. Still, samples should be collected for analysis. When decomposition is advanced, reproductive organs may still be useful for determining sexual maturity (look for fetus or corpora albicantia; check size of testes and degree of spermatogenesis). Obtaining teeth from large odontocetes requires an energetic approach with rugged tools, and dissecting earplugs demands considerable skill. Collection of life history samples from fresh carcasses may interfere with other procedures, e.g., samples of reproductive organs for histopathology or stomach contents for toxin analysis. In these circumstances, **investigators must agree on sampling priorities**.

Precautions

Establish sampling priorities. Examine the stomach last; once it is open, contents including fluids and parasites will quickly contaminate other organs. **Do not preserve stomach contents of fish-eating species in formalin, since this may dissolve small bones.** Ovaries should be packaged separately and labeled "left" or "right." Though perhaps obvious to the collector, it is wise to label the origin (position) of tooth samples. Teeth and gonads collected in a flurry of activity from many animals can easily be mislabeled and mismatched—with bizarre and confounding results.

10.9. CONTAMINANTS AND BIOTOXINS

10.9.1. Rationale

Marine mammals are a repository for contaminants passed through the food chain[1,69,72,102]. Stranded inshore residents provide information on regional conditions and trends, and potential insights into distinct subpopulations. Offshore species indicate the extent to which the oceans are being affected. Both groups may ultimately reveal the influence of contaminants and natural toxins on health[28] (*see also* **5.2.2**, **6.2.2**). Long-term banking of marine mammal tissues[11,12] enables researchers to follow patterns of biological toxins, organochlorines, heavy metals, and other contaminants, determine their impacts on animal health, and help guide future policy[73]. **To be effective, collection and preparation of specimens that form this resource must be systematic and comprehensive, and the samples matched with reliable life history data.**

Animal/Carcass selection: Code 2 ideal; **1, 3** limited; 4, 5 useless.

Specimens from healthy, well-nourished animals are necessary to determine contaminant levels in normal populations[11,14]. Blood samples (50 mL) and blubber biopsies from live animals can be obtained for this purpose[79,89]. Blood may reveal exposure but is less reliable than blubber for comparative studies or trend analyses, since blood contaminant levels can change rapidly and dramatically with nutritional status[54]. Samples from ill or emaciated individuals have limited value for determining trends in populations but may help elucidate the effects of toxins and contaminants on health[28,48,70].

Tissue autolysis and putrefaction diminish the value of contaminant analyses. In the U.S., the Marine Mammal Health and Stranding Response Program (MMHSRP) includes the National Marine Mammal Tissue Bank (NMMTB) and monitoring and quality assurance (QA) programs, which are administered through the National Institute of Standards and Technology (NIST)[12,14]. **Samples for the tissue bank must be collected by trained personnel within a specified period after documented death. Code 2** carcasses provide reliable samples for most other studies[78,89,91].

10.9.2. Sampling for Contaminants

A rigorous sampling protocol for **contaminants** (Fig. 10.17) has been developed by NIST's National Biomonitoring Specimen Bank for NMMTB banking and monitoring[11,14]. The protocol includes a target species list and specific criteria for each animal that must be met before samples can be collected for banking. Persons collecting samples specifically for the NMMTB must first be approved and trained by NIST personnel; NIST then provides the supplies required for sample collection[79]. The NIST protocols require collection of **~400-g samples** of blubber, liver, and kidney—enough to provide two ~150-g trimmed samples for

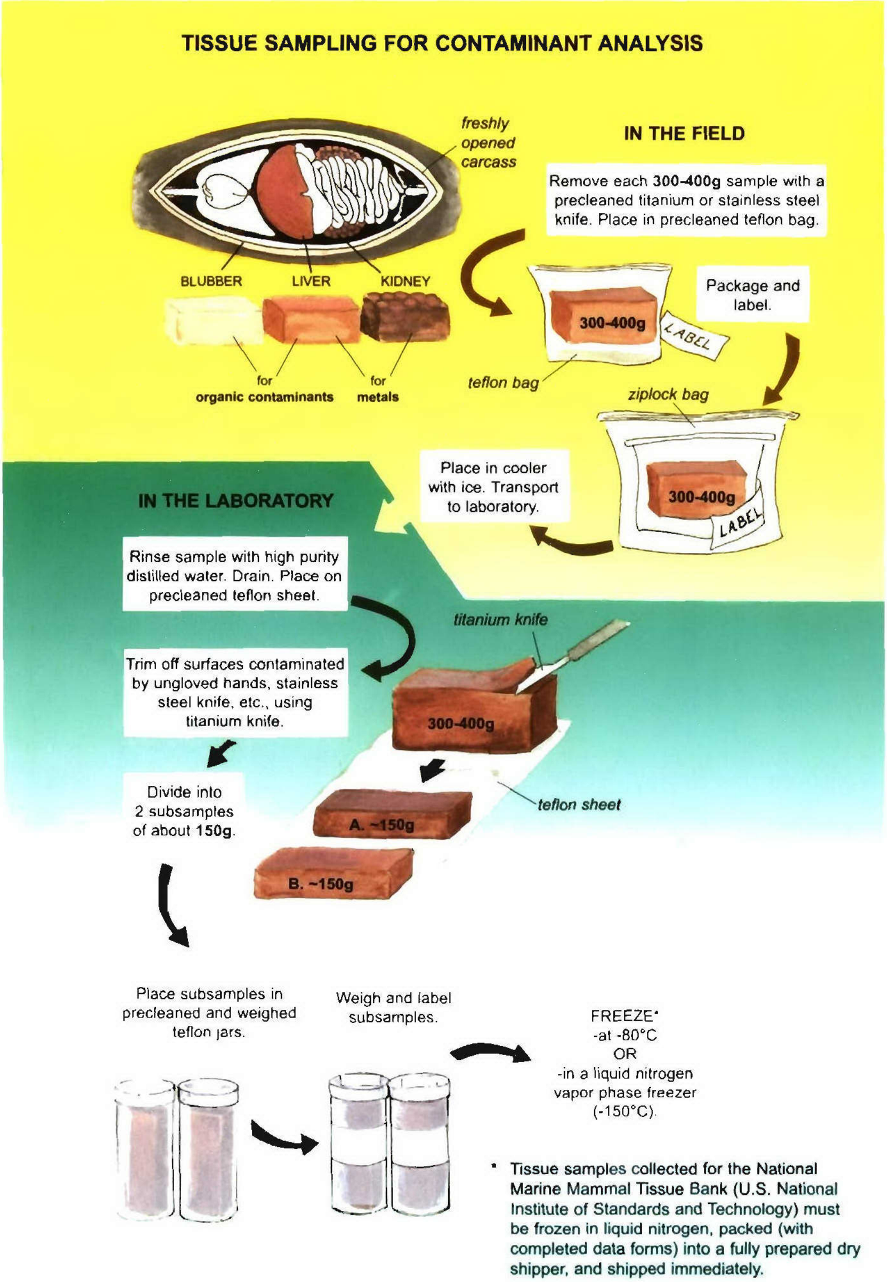


Fig. 10.17. Collecting tissue samples for contaminants analysis. **Note:** Samples for NIST banking must be collected by trained individuals and shipped within 48 hours of collection to the NIST Hollings Marine Laboratory, 331 Ft. Johnson Rd., Charleston, SC, 29464.

banking in liquid nitrogen vapor phase freezers (-150°C) at NIST facilities. For routine analyses in other laboratories, smaller quantities of tissue (**50 to 100 g**) are generally sufficient[13,78,89].

Blubber and other body fats store lipid-soluble organic contaminants in concentrations that remain stable for some time after death. Samples (about 10 x 10 cm) include the **full thickness of the blubber**, without muscle or epidermis (Fig. 10.18). Use a standard sampling site[11,14] (Fig. 10.19). Pinnipeds with thin blubber, e.g., fur seals, are sampled along the backbone, and those with thicker blubber in the sternal region or, for many phocids, at a site on the dorsal or dorso-lateral surface about 60% back along the body (standard length)[90]. The NIST protocol for cetaceans recommends sampling blubber anterior to the dorsal fin, about 10 cm posterior to the blowhole[14]; other protocols specify different sites (e.g., posterior to the dorsal fin[13,91], below the dorsal fin on the mid-lateral line[89], or in the sternal region[78]). Whatever site you use, be consistent until research provides clear guidance on the most reliable sampling site for the species or group. (Investigators may be contacted prior to necropsy to ensure appropriate sites are sampled.) Samples from manatees are taken from the outermost layer of blubber just to one side of the mid-ventral line[18] or at the level of the anus[86].

Liver accumulates most contaminants and some biotoxins. If toxicology is the priority, collect the entire liver from small carcasses; otherwise, package the remainder after taking other samples (Table 10.1). For large animals, standardized sampling sites include the caudal part of the left anterior lobe in pinnipeds and, in cetaceans, the distal end of each side of the medial indentation[11,14] (Fig. 10.19). In manatees, sample from the caudal tip of the right lobe[18]. Samples contaminated by bile are not useful.

Kidneys concentrate metals but are considered **secondary in value to liver** for these analyses[78]. Take both kidneys from small animals; from large pinnipeds and cetaceans, take the entire left kidney or a slice from the caudal end. Samples from manatees are taken in a similar fashion, but from the right kidney[18].

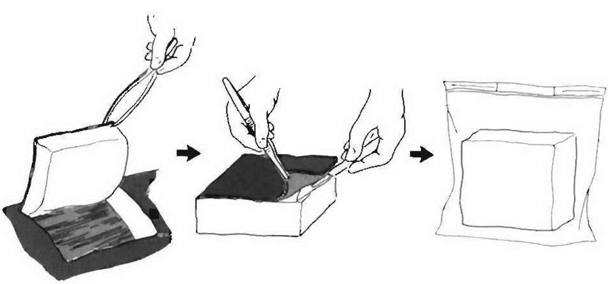


Fig. 10.18. Correct procedure for collecting blubber samples, showing removal of skin and muscle.

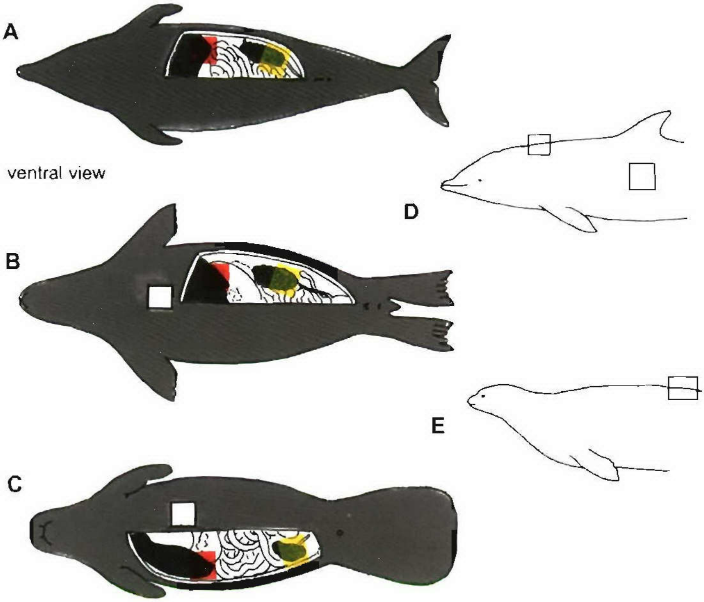


Fig. 10.19. Sites for collecting tissues for contaminant analysis. Sampling site for liver (**red**) and kidney (**yellow**) of cetaceans (**A**), pinnipeds (**B**), and manatees (**C**). Sampling site for blubber (white) of (**B**) robust pinnipeds, (**C**) manatees, (**D**) cetaceans, and (**E**) otariids and thin phocids. **Note:** optimal sampling sites may be species- or group-specific. Check with the laboratory or investigators requesting samples to ensure best results.

The value of **brain** and **muscle** is questionable[11]. **Brain** decomposes quickly. Removing it in small animals requires skill and, in larger whales, more effort than resources usually allow. Because brain tissue can be useful for evaluating acute exposure to certain contaminants[37,78], it may be worthwhile to take samples of brain or brain stem (sampled through the foramen magnum or at the second cervical vertebra[86]) from small **Code 2** animals (record the anatomic location). **Bone** may be taken in cases of suspected long-term exposure to lead. **Milk** samples (10 to 50 mL) can help evaluate a calf's or pup's exposure to organic compounds. **Stomach contents** and **bile** are ideal for assessing exposure to petroleum hydrocarbons[78]. Collect bile (~5 mL) with a syringe from the gallbladder (from the bile duct in cetaceans); protect bile samples from light, and freeze at -70°C or colder.

Ideal

Under ideal circumstances, the fresh, intact carcass is sampled in a clean laboratory. The NIST sampling protocol (Fig. 10.17) requires that the carcass be opened with **clean stainless steel instruments** by personnel wearing **non-powdered vinyl gloves** that are changed after each sample is taken with a clean stainless steel or **titanium knife**. Each sample is trimmed using a clean titanium knife, washed with high purity water, and cut into 150-g subsamples, which are placed in pre-weighed

Teflon jars. Containers are then refrigerated for immediate analysis, frozen at **-70°C (or colder) or in liquid nitrogen** for shipping, or stored in a liquid nitrogen vapor phase freezer (**-150°C**). At every stage, care is taken to **avoid chemical contamination** of the tissues. All chemicals are pesticide-free grade.

Practical

The rigorous sampling technique demanded for NIST banking purposes requires uncommon diligence and special training, and—outside the U.S.—dedicated funding. Most carcasses will not be moved to a laboratory for contaminant sampling, though it is possible to construct a protective lean-to at the stranding site.

Assume that samples collected within 24 hours of death are suitable. Remove at least 100 g of the required tissue as cleanly as possible using a stainless steel knife. Teflon containers are preferred, but other materials are acceptable for most studies, including borosilicate glass for organic analysis, and borosilicate glass or polyethylene for heavy metals analysis[78]. A practical approach is to collect oversize tissue samples (300 to 500 g) in aluminum foil, plastic bags, or buckets and transport them to the laboratory in a cooler with (but not in direct contact with) ice. Once in the laboratory, trim tissues within 1 to 2 hours. **Follow NIST (or other established) protocols as closely as possible so that results among and within laboratories can be compared.** Place liquid samples (e.g., milk) in clean glass containers if Teflon is not available, and line plastic lids with foil.

Precautions

Analyses for contaminants are time-consuming and expensive. Protocols on the beach can quickly break down. **Specimens are easily contaminated** by precipitation, sea spray, sand, blood, bile and urine, tobacco smoke, exhaust fumes, insect repellents, soaps, oils, rusty or improperly cleaned tools, plastics, and preservatives. Avoid sampling an organ in the region of ruptured membranes or previously cut surfaces. Sampling the leanest tissues first (e.g., kidney) will minimize contamination carried by fat to other tissues.

Stuffing numerous samples into a large container will retard the cooling of those at the center and may result in spoiling the whole lot. **Pack loosely with liberal amounts of coolant interspersed among the samples.** Samples for inorganic analyses can be stored safely at -20°C for months; temperatures above -80°C may result in the decay of some organic compounds, particularly in liver[78].

Results are meaningful only when analyses are completed by a qualified laboratory. In the U.S., the Analytical Quality Assurance component of the MMHSRP provides standard reference materials and coordinates inter-laboratory comparisons[12,14]. Analytical methods are advancing rapidly. **Work with an accredited laboratory; follow up-to-date protocols for collecting, processing, and transporting samples; and record any deviation from the protocol.**

10.9.3. Sampling for Biotoxins

For biotoxin analysis, collect 5 to 10 mL of blood from **Code 1** and **2** animals in a heparinized syringe. Preferably, separate the serum and freeze for shipment; otherwise, refrigerate and ship the samples using cold packs[101]. Depending on the suspected toxin (Table 10.3), collect 50-g samples of **liver**, **kidney**, **lung** (cranial pole), **stomach contents**, **feces**, and, if possible, **bile** and at least 3 mL of **urine** (collected with syringe) from **Code 2** carcasses; freeze and store at -20°C for shipment. For suspected domoic acid (ASP) or brevetoxin (NSP) poisoning, also collect 50-g samples of **brain**, **lung**, and **upper respiratory tract** and fix in 10% NB formalin for immunohistochemical (e.g., ELISA) studies[19].

Ideal

Biotoxins are cleared quickly from the body. Ideal samples are collected within a few hours of death and sent immediately to the laboratory for analysis. Samples of water, prey species, and tissues from any species stranding or dying concurrently are also collected and analyzed (*see* Box 10.5). Environmental data, including unusual mortality or illness of other species, are carefully compiled and documented.

Practical

Collecting **stomach contents** (with no associated water) and **tissue samples for biotoxins** is a realistic goal when carcass quality permits.

Precautions

Biotoxins are quickly metabolized. Documenting coincidental illness or mortality of other species and occurrences of harmful algal blooms can provide essential evidence to support a role for biotoxins in marine mammal strandings or death.

Table 10.3. Specimen collection for biotoxins affecting marine mammals[88,89,93,95,101]

Human illness	Organism	Major toxins	Exposure route (marine mammals)	Marine mammal samples
PSP	*Alexandrium* spp.	saxitoxin	clams, mussels, zooplankton, fish	^{1}stomach contents, liver
ASP	*Pseudonitzchia* spp. *Nitzchia* spp.	domoic acid	fish, various invertebrates	^{1}kidney, urine, serum, feces ^{2}brain
NSP	*Karenia brevis* *Gymnodinium* spp. *Chattonella* spp.	brevetoxin	fish, shellfish, aerosols, water	^{1}liver, lung, stomach contents, bile, urine or kidney, serum ^{2}respiratory tract, brain
CFP	*Gambierdiscus toxicus*	ciguatoxin	reef fish	^{1}liver, kidney

^{1}50-100g tissues, >3 mL urine, >10 g feces in plastic bag or bottle; 5-10 mL serum; freeze at -20°C for shipment.

^{2}Fix in 10% NB formalin for immunoperoxidase testing.

PSP=paralytic shellfish poisoning; **ASP**=amnesic shellfish poisoning; **NSP**=neurologic shellfish poisoning; **CFP**=ciguatera poisoning.

10.10. MICROBIOLOGY

10.10.1. Rationale

Marine mammals harbor a variety of microorganisms, some of which are known pathogens. We now recognize that certain endemic diseases can periodically erupt into epidemics causing large-scale mortalities, and other infections may cause chronic disorders that can influence the status of populations or stocks (*see* **5.2.1** and **6.2.1**).

Animal/Carcass selection: Code 1, 2 ideal; **3** limited; 4, 5 useless.

It can be difficult to associate bacteria or fungi isolated from a carcass with specific lesions. Bacteria that are part of the normal flora may proliferate rapidly after death and interfere with successful isolation of an offending pathogen. Bacteria associated with active infectious processes tend to endure longer in viable concentrations, and certain species may be isolated from more deteriorated carcasses (**Code 3**), even frozen stored specimens.

Most viruses are fragile and have a short life span in decomposing tissue, yet some persist long enough to be harvested, cultured, and identified. For example, the influenza viruses in seals can be cultured and remain infective in both decomposing and frozen carcasses[105]. With the advent of PCR, specific pathogens such as morbillivirus can potentially be detected in tissues, even those with moderate to advanced autolysis.

10.10.2. Sampling

Sample selection for bacteriology and virology may be determined largely by the nature of the gross pathologic findings. Refer to Figs. 10.21 and 10.22 for sampling protocols. However, systematic sampling, when possible, may provide the opportunity to determine normal tissue flora and assess the degree of antimicrobial resistance.

Samples should be taken aseptically, first from external surfaces, then from body cavities, and then from internal organs as soon as they are exposed and handled. The core of a fleshy or hollow organ, or fluid-filled lesion (e.g., abscess) is sampled by inserting a swab in an incision made through the sterile surface. First disinfect the surface by searing (Fig. 10.20) or by applying 10% formalin or 70% ethanol and allowing it to air dry. Fluid samples from a cavity are taken by aspiration (through a sterile surface) before or upon opening. Tissues destined for laboratory sampling (sear-sampling, cultures, impression smears) should be large enough (about 6x6x6 cm) to allow for trimming and have one capsular or serosal surface intact to prevent post-mortem bacterial or fungal contamination. Smaller samples (1- to 2-cm cubes) are generally sufficient for viral analyses.

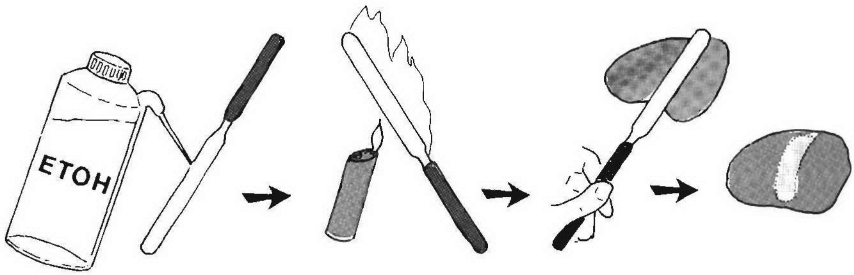


Fig. 10.20. Sterilizing tissue surface by searing.

Take separate samples for bacteriology and virology, and freeze additional tissues for later use. Large lesions are sampled from two or three distinct regions; collect any lymph nodes in the vicinity. If intestinal infection is suspected, tie off a 10-cm loop and place in a sterile container[51]. Bone marrow remains uncontaminated longer than other tissues[21] and may be worth sampling when carcass quality is questionable. In pinnipeds, a bone biopsy needle can be introduced through a skin incision into the femur[24]. In cetaceans, sampling from the 5th to 8th vertebral bodies anterior to the flukes is recommended[98]. If biopsy needles are unavailable, collect and submit an entire small bone or a section of a larger one.

Place bacteriology or virology swabs in the appropriate transport medium (generally available from diagnostic laboratories or laboratory supply companies) (Figs. 10.21, 10.22). Aspirated pus from abscesses and other lesions where anaerobic bacteria are suspected should be transported in appropriate anaerobic vessels. Package tissues in sealed, sterile, leak-proof bags or jars. Label, cool, and transport to the laboratory immediately. **Freezing can degrade samples for bacterial culture**, but if long delays are unavoidable (>24 hr), freeze at -70°C or colder; avoid using dry ice for samples destined for bacterial culture, as exposure to carbon dioxide will result in bacterial loss. Record conditions of collection and storage.

Fecal samples that cannot be cultured immediately should be frozen in a plastic bag or placed in a stool preservative (equal volumes of 0.033 M phosphate buffer and glycerol).

For identifying **fungal agents** in skin, scrape the lesion with a scalpel blade, place material in a plastic bag, and refrigerate. In pinnipeds, remove a number of hairs from the affected area and place in a sterile bag or container. Samples for special fungal culture should be handled in the same manner as those for bacterial culture and refrigerated until they can be inoculated onto a suitable growth medium.

Molecular and other advanced diagnostic methods, such as PCR, electron microscopy (EM), and ELISA are becoming widely used tools for pathogen identification. These methods require small samples and may be useful for tissues that are too autolyzed for conventional methods such as bacterial culture or virus

isolation. Even if funding is unavailable for immediate analysis, well archived samples are valuable for future studies. Samples for **PCR** analysis (for both DNA and RNA) can be collected, packaged, and stored according to the guidelines in Box 10.2 (p. 214). Samples of lung and lung-associated lymph node are preferred for detecting and identifying morbilliviruses. Preserve tissue samples (~1 mm^3) for **EM** evaluation in 3% glutaraldehyde; swabs for EM and PCR studies can be placed in viral transport medium. **Ideally, consult with the laboratory prior to sample collection to ensure preferred methodology.**

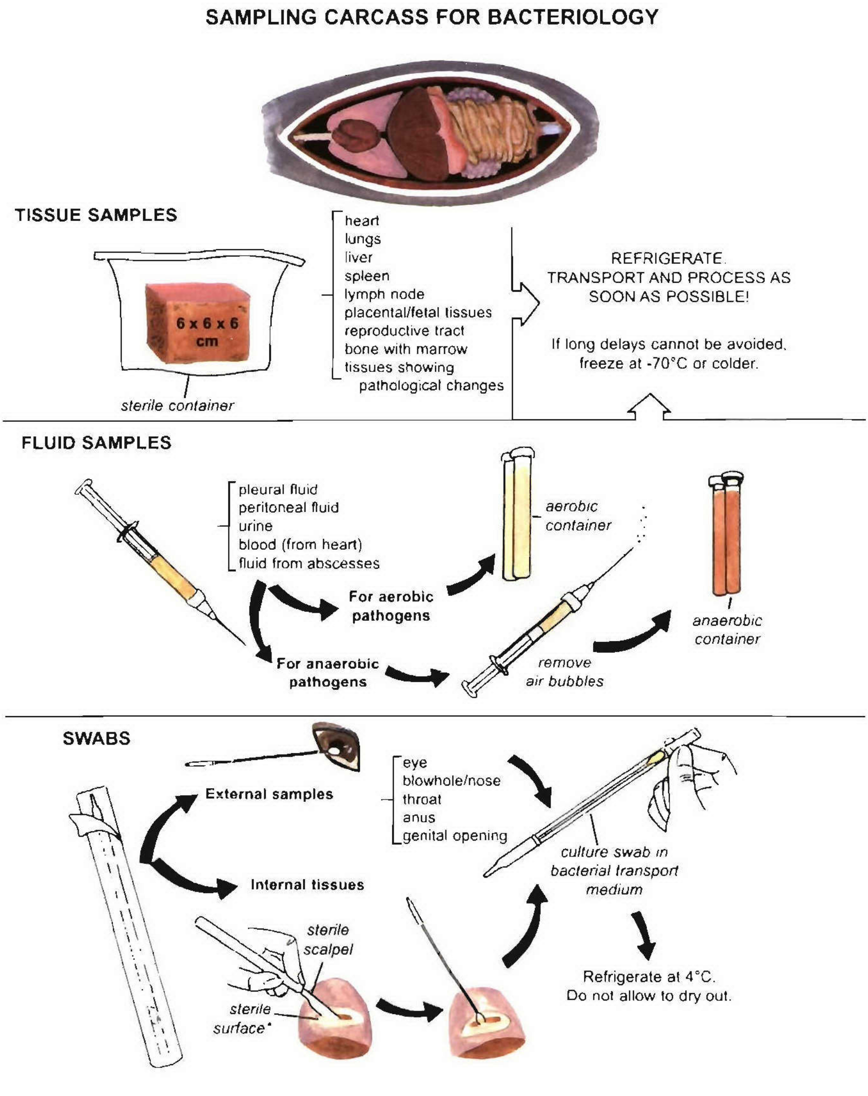


Fig. 10.21. Collecting samples for bacteriology. (**See* Fig. 10.20.)

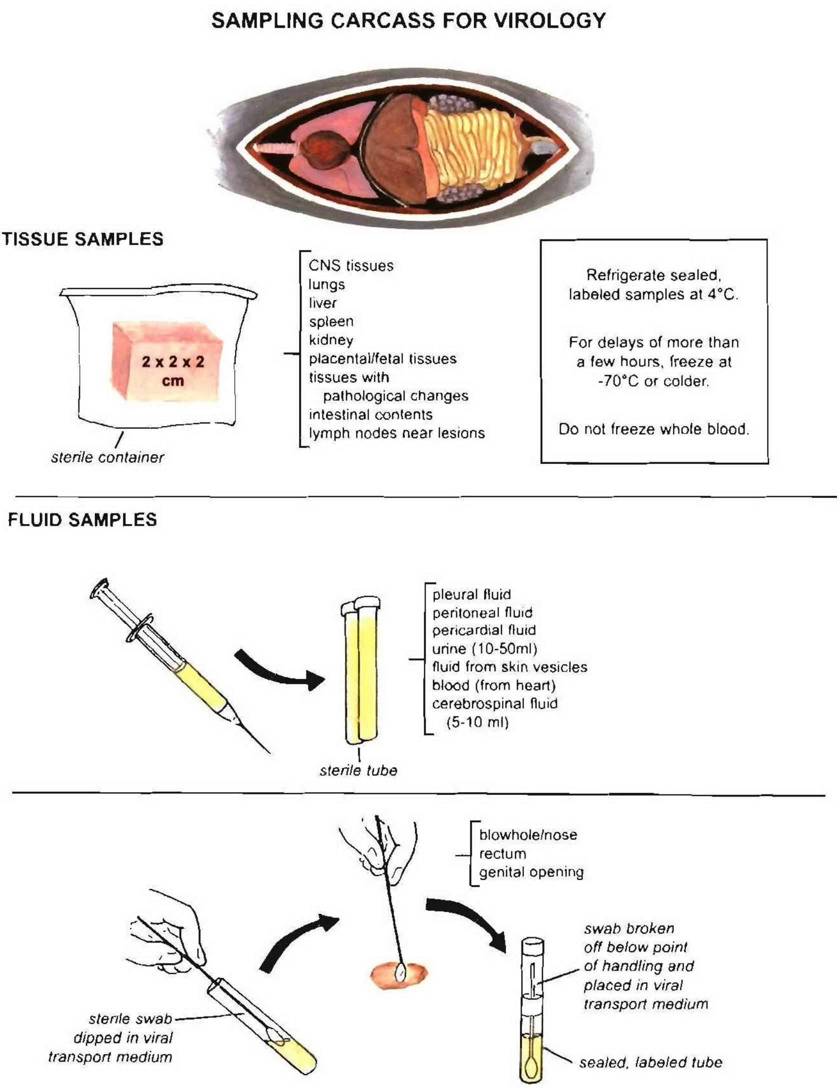


Fig. 10.22. Collecting samples for virology.

Ideal

The carcass is fresh and shaded, and the weather cool. All equipment required for sampling tissues for viruses, bacteria, and fungi, along with fresh transport media and culture swabs is available in your field kit. Collection protocols are strictly followed by trained individuals. Arrangements have been made for immediate transport to the diagnostic laboratory. The laboratory has been involved in the planning, has been notified of the stranding, and is prepared to receive and process all samples (e.g., has inoculated appropriate selective media for specific pathogens, such as *Clostridium difficile*, *Listeria* spp., or *Salmonella* spp.).

Practical

Tissues from **Code 2, 3**, and possibly **Code 4** carcasses can be swabbed or sampled for diagnostic evaluation. Sampling for microbiological testing is worth the time and effort required, however, only when the necessary equipment is available, the samples are collected according to protocol, and all arrangements have been made for transportation and processing. **There is little latitude between the ideal and the practical approach.**

Precautions

Discard samples suspected of being contaminated, including swabs that have contacted anything other than the intended fluid or tissue. Do not allow specimens to dry out. Do not sample internal organs once the gut has been opened or is compromised. Team members must wear gloves and protect exposed skin, mucous membranes, and eyes from contact with carcass material.

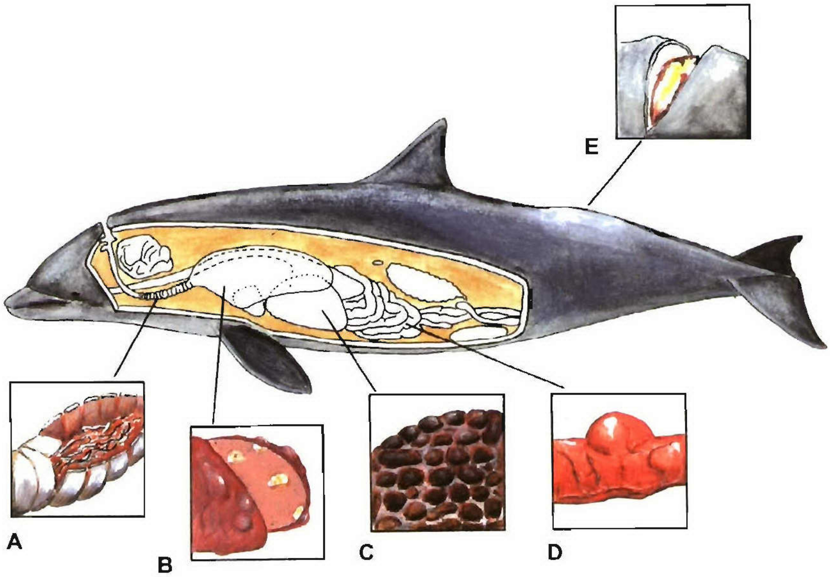


Fig. 10.23. The internal examination: examples of pathologic conditions and their description. **A.** Trachea: a tangled mass of nematodes (worms) partially obstructs the trachea. **B.** Lung: lung contains a number of abscesses filled with cottage cheese-like exudate under the surface and throughout the organ. **C.** Liver: liver surface is cobblestoned because of a mixture of scarring (depressions) and regeneration (nodules). **D.** Gut: smooth nodule (probably a tumor) protrudes from the external surface of the intestine. **E.** Back: incision of a swelling visible on the back behind the dorsal fin reveals a mixture of pus and blood in the blubber and underlying muscle.

Fig. 10.24. Collecting tissues for histopathologic examination.

10.11. GROSS PATHOLOGY AND HISTOPATHOLOGY

10.11.1. Rationale

Carcasses are a biological record of endemic or emerging (or re-emerging) illnesses within populations, and of conditions that might have led the animals to strand. The information is gleaned by careful selection of tissue samples for microscopic or histopathologic studies. In cases of suspected human-related injury, histopathology can help determine whether the damage occurred before or after death.

Animal/Carcass selection:

Gross pathology: **Code 2, 3** ideal; **1, 4** limited; 5 useless.

Histopathology: **Code 2** ideal; **1, 3** limited; 4, 5 useless.

Injuries such as fractures and lacerations remain evident for long periods of time, as do certain firm lesions (e.g., tumors). Carcasses too decomposed for histopathology may still be useful for describing gross pathologic conditions. Brain, spleen, liver, intestine, pancreas, stomach, and other enzyme-rich organs are generally the first to deteriorate[21].

10.11.2. Sampling

The carcass should be examined systematically (*see* **10.5**) and samples taken from representative tissues and any areas with visible lesions or suspected pathologic change (Fig. 10.23); samples should also be taken from lymph nodes that drain the site. **Because all pathologic conditions cannot be judged grossly, we suggest taking samples from all organs, even those that appear normal.** At a minimum, take samples of skin, heart, lymph nodes, intestines, stomach, lung, adrenal glands, liver, kidney, gonads, spleen, and brain. Avoid crushing the samples.

A sample should include the abnormal tissue and adjoining normal tissue (Fig. 10.24). It must be thin enough to allow penetration of the preservative (i.e., < 1 cm thick—preferably about 5 mm) but can be up to 2 to 3 cm in greatest dimension. Make numerous parallel cuts in thicker specimens to permit adequate preservation.

Preserve tissues in **10% NB formalin**, using a minimum ratio of 10 volumes of preservative to 1 volume tissue. (Samples for EM are finely diced or minced [1 mm^3] and placed in 3% glutaraldehyde.) Place samples in watertight glass jars, plastic containers, or bags; for tissues such as muscle, lymph node, gonads, or skin, include sampling location on the label.

<u>Ideal</u>

Trained, well equipped personnel examine fresh carcasses in clean surroundings. Lesions are described and, if unusual, illustrated or photographed. Representative samples from each are collected, properly trimmed, and immediately placed into

Box 10.2. Samples for PCR (*courtesy of* T. Romano[85])

For those with only ice, cooler, and formalin:

- Place a <0.5-cm cube of tissue in 10% NB formalin and place a second <0.5-cm cube of tissue in a whirlpack bag on ice and freeze. In the laboratory, archive frozen samples in liquid nitrogen or at -80°C. The tissues in formalin may remain so.

Other preservation methods include:

- Snap freeze <0.5-cm cube of tissue in a cryovial in 1) liquid nitrogen; 2) a dry liquid nitrogen shipper; or 3) dry ice immediately after harvest.
- Store in liquid nitrogen for archival purposes or, if liquid nitrogen is not available, store in a -80°C freezer.

OR

- Submerge tissue (<0.5-cm cube) in RNAlater Stabilization Reagent (Qiagen or Ambion, Inc.) (10 µl of reagent per 1 mg of tissue) immediately after harvest.
- Samples can be kept for 7 days at 18-25°C, or 4 weeks at 2-8°C, allowing processing, transportation, storage, and shipping of samples without liquid nitrogen or dry ice.
- For archival purposes store samples at -20°C or -80°C in the stabilization reagent.

clean containers with preservative of appropriate strength and volume. Jars are labeled inside and out, and protected from heat, direct sunlight, or freezing. Samples taken are recorded on the data form.

In the U.S., necropsy teams often collect two complete sets of fixed tissues. One set is forwarded to the histopathologist working with the team or is retained by the local network; the other is sent to the Armed Forces Institute of Pathology, Registry of Veterinary Pathology, which maintains a centralized repository of marine mammal tissues.

Practical

In the field, the depth of the examination is limited by the quality of the specimen, environmental conditions, resources, and team experience. A small carcass can usually be examined thoroughly. A complete examination is difficult to accomplish in a mass stranding (select the freshest), on huge animals (work as a team), or in foul weather (wait for a break). In some cases it may be possible to transport fresh, small or even medium-sized carcasses to a laboratory for full investigation.

Precautions

Thick tissues packed in a jar with insufficient preservative will rot. Pay attention to sample size and the proportion of preservative. Frozen tissues, because they have ruptured cell walls, tend to liquefy when they thaw, leaving them unacceptable for histopathology.

Box 10.3. Human-Related Injuries[4,25,42,50,63,83]

Human-related injuries vary from gunshot wounds and boat strikes to those caused by interaction with fishing gear and marine debris. Some injuries are evident, such as propeller cuts, lesions with associated rope or net fragments, and skin abrasions, typically along the leading edges of the fins and flukes. Other injuries, such as fractures caused by vessel strikes, bullet wounds, or intestinal obstruction due to foreign body ingestion, may require a detailed examination of both soft and bony tissues. In large whales, ruling out vessel strike as the cause of death may require dissecting the entire carcass down to the bone, including the skull, ribs, and vertebral column. Take extra care to distinguish between damage caused by stranding or scavengers and injuries due to nets, gunshot wounds, etc. In some instances, traumatic wounds may be inflicted post mortem; assess the impact site for hemorrhage, edema, and other changes to help distinguish ante- versus post-mortem change. Taking radiographs of small carcasses with suspected internal injuries prior to necropsy can help direct the investigation and prevent loss or damage of evidence. Specifically designed human-interaction forms used in conjunction with routine necropsy protocols will help insure collection of essential samples and data. Document all findings with descriptions and photographs. Be careful! Do not speculate!

For these strandings in U.S. waters, a human-interaction data form should be completed and sent with other documentation (e.g., labeled photographs or videotapes, or recovered bullets or net fragments) to NMFS, following protocols for maintaining chain of custody[106]. These records help managers and enforcement officials evaluate the nature and importance of these events and may serve as vital evidence in cases involving legal action. *See* Appendix D: *Protocol for Evaluating Marine Mammals for Signs of Human Interaction* and Appendix C: *Marine Forensics Chain of Custody*.

Box 10.4. Investigating Suspected Noise-Related Cetacean Strandings

Cetacean strandings associated with sound generated by human activities (e.g., military sonar or air guns used for oil and gas exploration) are controversial and require comprehensive investigation. Examination of beaked whales and other cetaceans that have stranded following presumed exposure to high intensity, low and mid-frequency naval sonar revealed multiple areas of hemorrhage, primarily in or around the inner ears, brain, acoustic jaw fat, and kidneys[7,100], as well as vascular lesions suggestive of decompression sickness ("the bends")[47]. Comprehensive protocols for sample and data collection for such events have yet to be established. The general guidelines below provide a basic framework for further development.

Initial evidence

Investigate acoustic trauma as a cause or contributor to strandings in the following circumstances[7,36,100]:

- Mass- or multi-species strandings of beaked whales over a period of a few days
- Multi-species cetacean strandings, in the absence of other apparent causes of unusual mortality (e.g., toxic algal bloom or offshore fisheries)
- Any cetacean stranding that coincides with local activities involving military sonar, air gun activity, or other sources of intense underwater sound
- Any mass- or multi-species stranding in which animals share pathologic findings suggestive of acoustic trauma.

Necropsy and sample collection

Ideally, transport fresh small or even medium-sized carcasses to a laboratory for full investigation, or arrange for expert pathologist consultation and examination in the field. Conduct a comprehensive necropsy to evaluate other potential causes of stranding or death, and include sample collection and examination for evidence of lesions that may be associated with noise exposure, as described below.

1. Brain and spinal cord[35,46]

   After the external examination (*see* **10.5** #3-4), examine the brain and spinal cord. (If unfeasible, continue to #2.)

   - Ideally, examine and sample the brain and spinal cord without introducing gas (as artifact) into the CNS circulation. Although attempts can be made to tie-off blood vessels around the cranium, marine mammal cardiovascular adaptations make preventing gas entry into the CNS vasculature problematic. Alternatively, prior to removing the head, carefully open a window in the skull and, after excising the dura mater, examine the blood vessels of the brain surface for hemorrhages, potential gas emboli, and other lesions. Describe and photograph any suspected bubbles/lesions.
   - Remove the head at the atlanto-occipital joint; collect a sample of cervical spinal cord and fix in 10% formalin.
   - Collect and preserve the brain in formalin for histopathology[84] (*see* **10.5** #12). Continue to #2.

(*continued*)

Box 10.4. Investigating Suspected Noise-Related Strandings (*continued*)

2. Ear block (tympanoperiotic complex with surrounding tissue)[49]

Logistics and expertise permitting, remove and preserve the tympanoperiotic complex with surrounding tissue for shipment to a qualified laboratory for further examination. (If unfeasible, continue to #3.)

- Position the skull on its dorsal surface.
- Remove the lower jaw and soft issues to expose the tympanic area. Assess the mandibular fat for hemorrhage[7] (most obvious at the interface between the fat and bone).
- Using a chisel, screwdriver and saw, as necessary, remove the tympanoperiotic complex (the tympanic bones and the periotic bones with the attached flanges). Leave a generous block of surrounding tissue to protect potentially fragile lesions.
- In fresh specimens, inject formalin through the round window with a 22- to 25-gauge needle to better preserve the inner ear.
- Place tissues in 10% neutral buffered (NB) formalin for one week before shipping; change the formalin after one week and at least twice during the first month if shipping is delayed. Prior to shipping, wrap the tissues in gauze soaked with 10% NB formalin, place in a bag or container, tape to prevent leakage, and pack with cushioning to prevent damage (*see* **10.14**).

3. If the ear block cannot be properly collected and preserved in the field, collect the head (preferably after the brain and spinal cord have been examined and sampled) for later computerized tomography (CT) analysis, ear extraction, and examination. Refrigerate for immediate investigation; otherwise, freeze and ship frozen. In the laboratory, thaw the head in fixative to minimize deterioration.

4. Other tissues

- Remove the eyes. Assess the retrobulbar periorbital fat for bleeding[81].
- Incise the larynx and assess the mucosa for evidence of hemorrhage[81] (*see* **10.5** #7).
- In fresh carcasses, examine the vasculature of the intestines, intestinal mesentery, liver and kidneys for intravascular gas bubbles and hemorrhage, and photograph any suspected abnormalities[36,47] (*see* **10.5** #8).

Fix tissues for histopathology in 10% NB buffered formalin at a ratio of 1 part tissue to 10 parts formalin (*see* **10.11**).

Supplementary data

Supplementary data provide essential circumstantial evidence. Document the following in as much detail as possible (e.g., photographs, GPS, aerial surveys):

- Potentially related strandings (species, numbers, locations; collect skin samples from all animals for genetic analysis and to confirm species and relatedness)
- Spatial and temporal pattern of live and dead strandings
- Pre-stranding and stranding behavior
- Presence of floating carcasses and/or live animals in the area
- Natural (e.g., seaquakes) or human activities (e.g., seismic surveys or naval exercises) in the area
- Historical pattern of strandings in the region.

10.12. PARASITOLOGY

10.12.1. Rationale

Virtually every marine mammal carcass has parasites[26,29,40,75]. Most of these are innocuous and have value as ecological markers. Occasionally these, and others, can cause serious illness in individuals and, perhaps, ultimately affect populations (*see* **5.2.1**, **6.2.1**, and **9.2.1**). Correctly identifying a novel or unusual parasite may help determine a source of exposure. Efforts to document parasite transfer (e.g., *Toxoplasma gondii* and *Sarcocystis neurona*) from terrestrial species may provide valuable insights into their pathology and epidemiology.

Animal/Carcass selection: Code 2, 3 ideal; **1, 4** limited; 5 useless.

Examination for parasites is practical in carcasses suitable for pathologic investigation.

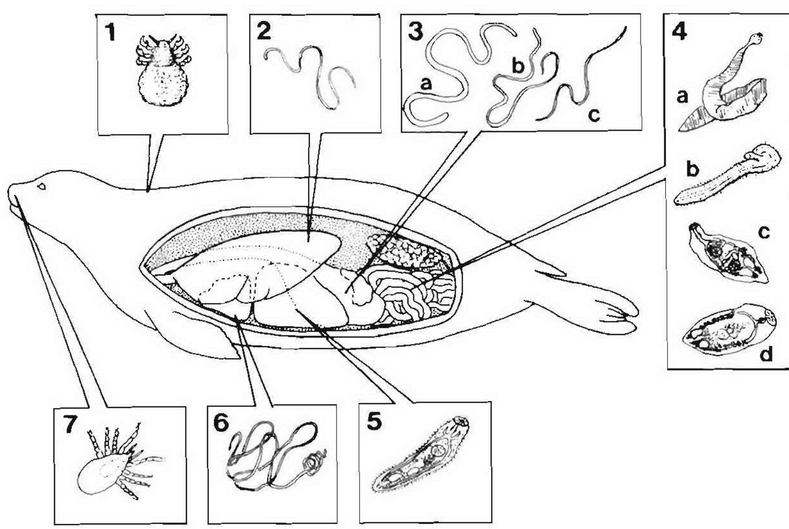


Fig. 10.25. Some parasites of phocids in North American waters[27,29,55,56]. **1. Skin:** *Echinophthirius horridus* (2-4 mm). **2. Lungs:** *Otostrongylus circumlitus* (50-70 mm). **3. Stomach: a,** *Anisakis simplex* (>60 mm); **b,** *Pseudoterranova decipiens* (40-70 mm); **c,** *Contracaecum osculatum* (<60 mm). **4. Intestines: a,** *Diphyllobothrium* sp. (*D. lanceolatum*, 45-55 mm); **b,** *Corynosoma* sp. (3-6 mm); **c,** *Phocitrema fusiforme* (1-1.5 mm); **d,** *Cryptocotyle lingua* (0.5-2 mm). **5. Liver, gall bladder, bile and pancreatic ducts:** *Orthosplanchnus* sp. (<20 mm). **6. Heart:** *Acanthocheilonema* (=*Dipetalonema*) *spirocauda* (140 mm). **7. Nasopharynx:** *Halarachne* sp. (1 mm). **Note:** Protozoan parasites (e.g., *Toxoplasma gondii*) can be visualized microscopically in brain or muscle tissue or detected serologically.

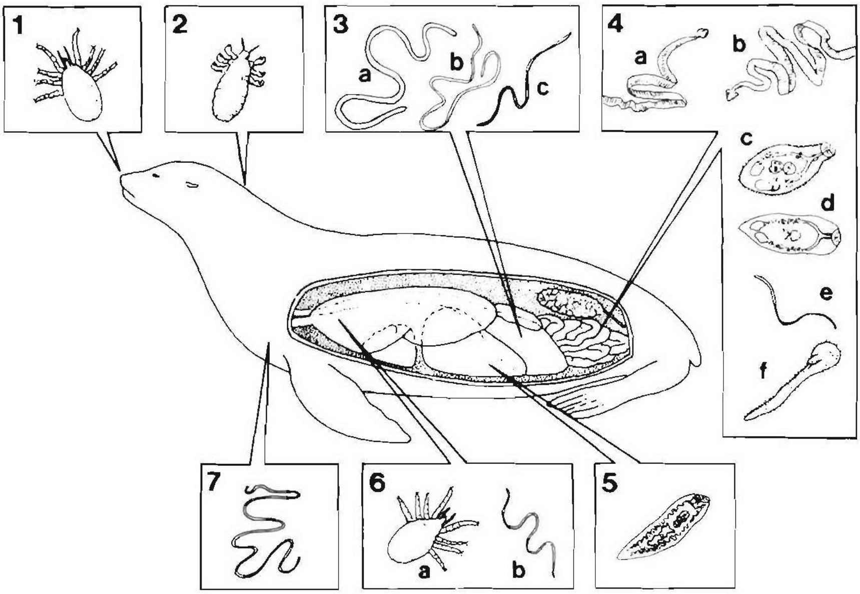


Fig. 10.26. Some parasites of otariids in North American waters[27,29,55,56]. **1. Nasopharynx:** *Orthohalarachne* sp. (0.6-5 mm). **2. Skin:** *Antarctophthirius* sp. (2-4 mm). **3. Stomach:** **a,** *Anisakis simplex* (>60 mm); **b,** *Pseudoterranova decipiens* (40-70 mm); **c,** *Contracaecum osculatum* (<60 mm). **4. Intestine:** **a,** *Diphyllobothrium* sp. (*D. pacificum*, 100-250 mm); **b,** *Diplogonoporus* sp. (>500 mm); **c,** *Pricetrema zalophi* (<0.5 mm); **d,** *Cryptocotyle jejuna* (0.5-2 mm); **e,** *Uncinaria* sp. (8-16 mm); f, *Corynosoma* sp. (3-8 mm). **5. Liver, gall bladder and bile ducts:** *Zalophotrema hepaticum* (10-15 mm). **6. Lungs and trachea:** **a,** *Orthohalarachne* sp. (0.6-0.8 mm); **b,** *Parafilaroides* sp. (<25 mm). **7. Muscle and fascia:** *Acanthocheilonema* (=*Dipetalonema*) *odendhali* (55-120 mm).

10.12.2. Sampling

Parasites in marine mammals tend to occur in predictable sites (Figs. 10.25-10.30) that can be mapped after examining a few carcasses. Collect and preserve samples of loose parasites, lifting them carefully with forceps or fine needles. Some embedded parasites, such as lungworms, and *Crassicauda* in mammary glands or fascia, should be taken with a section of affected tissue for later identification. Cestode specimens must be removed with the head intact. Protozoan parasites can be collected from the blowholes of live cetaceans by holding a pre-labeled glass slide 2 to 4 inches above the blowhole for 3 to 5 exhalations and preserving in the field as follows: air dry the slide for 5 to 10 minutes; fix in absolute methyl alcohol for 5 minutes; air dry; fix in 10% NB formalin for 5 to 10 minutes; and air dry. These slides are then ready for staining and evaluation[76].

A variety of methods are used to preserve other parasites[17,30,77]. Under field conditions, ectoparasites can be fixed in 5% glycerin in 70% ethanol (95 mL 70% ethanol and 5 mL glycerin), and algae in 5% NB formalin. Similarly, alcohol-

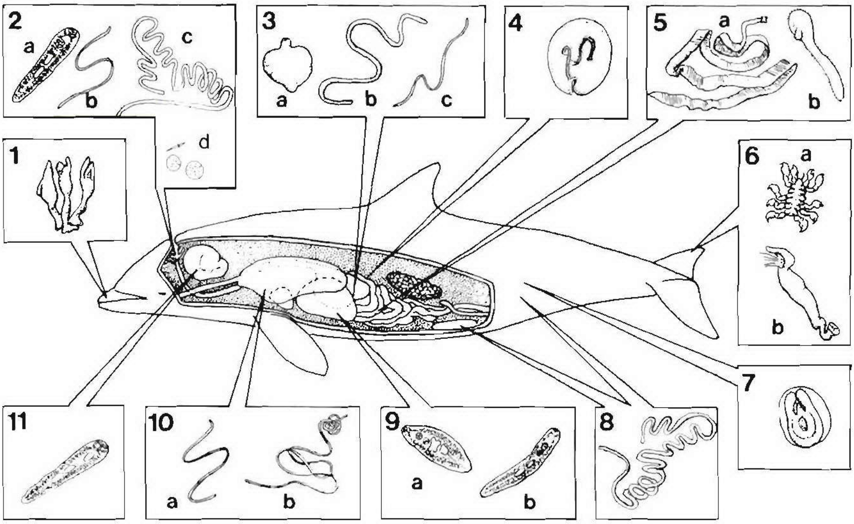


Fig. 10.27. Some parasites of toothed whales in North American waters[27,29,55,56]. **1. Teeth:** *Conchoderma* sp. (<15 cm). **2. Cranial sinuses: a,** *Nasitrema* sp. (10-35 mm); **b,** *Stenurus* sp. (20-50 mm); **c,** *Crassicauda* sp. (>500 mm); **d,** protozoans. **3. Stomach: a,** *Braunina cordiformis* (4-9 mm); **b,** *Anisakis* sp. (>60 mm); **c,** *Contracaecum* sp. (<60 mm). **4. Abdominal cavity and mesentery:** *Monorygma grimaldi* plerocercoid cyst (20-30 mm). **5. Intestine: a,** *Tetrabothrium fosteri* (25-65 mm); **b,** *Corynosoma* sp. (3-6 mm). **6. Skin: a,** *Syncyamis* sp. (2-7 mm); **b,** *Xenobalanus* sp. (<50 mm). **7. Blubber:** *Phyllobothrium delphini* plerocercoid cyst (4-9 mm). **8. Mammary glands, muscle and fascia:** *Crassicauda* sp. (>500 mm). **9. Liver, pancreas and bile ducts: a,** *Campula oblonga* (3-6 mm); **b,** *Oschmarinella* sp. (30-35 mm). **10. Lungs and trachea: a,** *Stenurus* sp. (20-50 mm); **b,** *Halocercus* sp. (17-80 mm). **11. Brain:** *Nasitrema* sp. (10-35 mm).

formalin-acetic acid (AFA) offers a simple, practical field method for fixing most endoparasites (Fig. 10.32), although specimen quality may be improved by following more detailed protocols[17,32,77]. Nematodes, for example, are preferably fixed in 10% glycerin in 70% ethanol (90 mL 70% ethanol and 10 mL glycerin), heated to steaming (not boiling) to improve penetration of the cuticle.

AFA Solution: 100 mL formaldehyde (37-40%)
450 mL distilled water
500 mL ethanol (95%)
50 mL glacial acetic acid

Feces can be refrigerated for transport to the laboratory for examination. Alternatively, fix a 5- to 10-g sample in an equal volume of hot 10% NB formalin if possible, and transfer later to 70% ethanol.

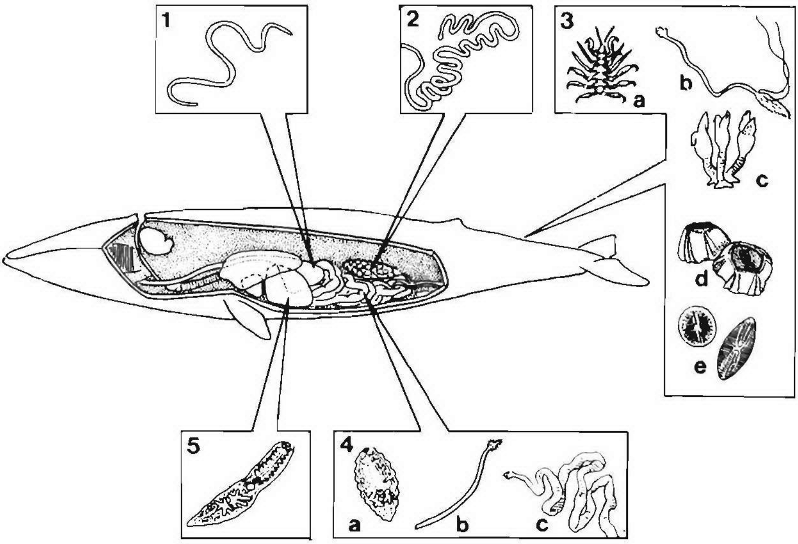


Fig. 10.28. Some parasites of baleen whales in North American waters[27,29,55,56]. **1. Stomach:** *Anisakis* sp. (>60 mm). **2. Urogenital tract:** *Crassicauda* sp. (>500 mm). **3. Skin: a,** *Cyamis* sp. (10-30 mm); **b,** *Penella balaenopterae* (300 mm); **c,** *Conchoderma* sp. (<15 cm); **d,** *Coronula* sp. (<50 mm); **e,** diatoms (*Navicola* sp., *Cocconeis ceticola*). **4. Intestine: a,** *Ogmogaster plicatus* (6-14 mm); **b,** *Bolbosoma* sp. (35-100 mm); **c,** *Diplogonoporus* sp. (>500 mm). **5. Bile ducts:** *Lecithodesmus goliath* (70-90 mm).

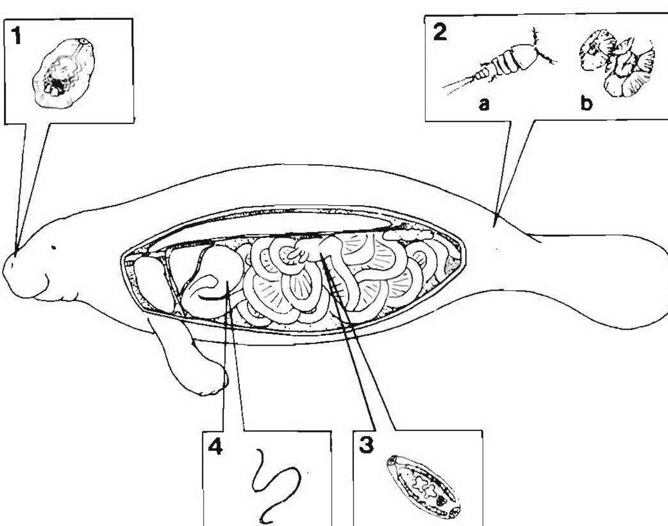


Fig. 10.29. Some parasites of the West Indian manatee[10,18]. **1. Nasal passages and bronchi:** *Cochleotrema cochleotrema* (7-10 mm). **2. Skin: a,** *Harpacticus pulex*; **b,** barnacles. **3. Intestine and caecum:** *Chiorchis fabaceus* (10 mm). **4. Stomach:** *Heterocheilus tunicatus* (30-35 mm).

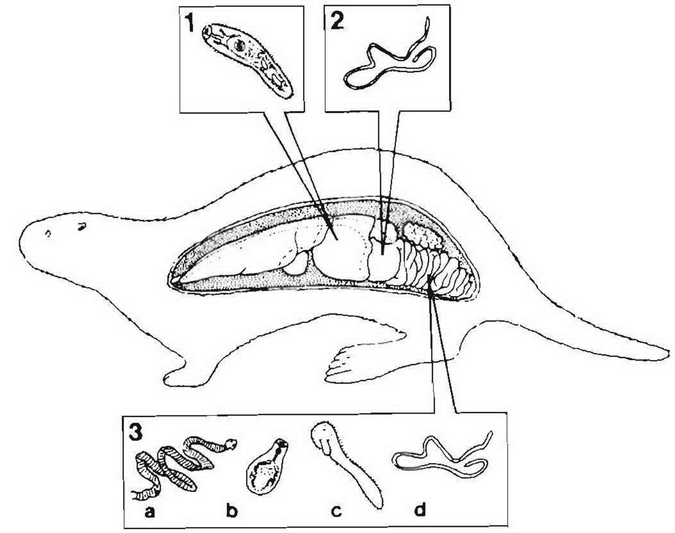


Fig. 10.30. Some parasites of the sea otter in North American waters[29,80] (*see also* **9.2.1**). **1. Gall bladder:** *Orthosplanchnus fraterculus* (<20 mm). **2. Stomach:** *Pseudoterranova decipiens* (<60 mm). **3. Intestine: a,** *Diplogonoporus tetrapterus* (>500 mm); **b,** *Microphallus pirum* (<0.5 mm); **c,** *Corynosoma* sp., *Profilicollis* sp. (9-28 mm); **d,** *Pseudoterranova decipiens* (<60 mm). **Note:** Protozoans (e.g., *Toxoplasma gondii*) can be visualized microscopically in brain or muscle tissue.

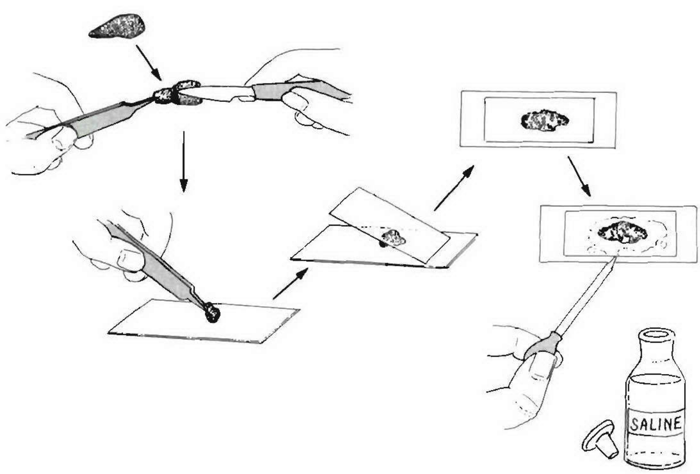


Fig. 10.31. Crush-smears of cetacean brain and mammary tissue may show presence of parasite ova and larvae.

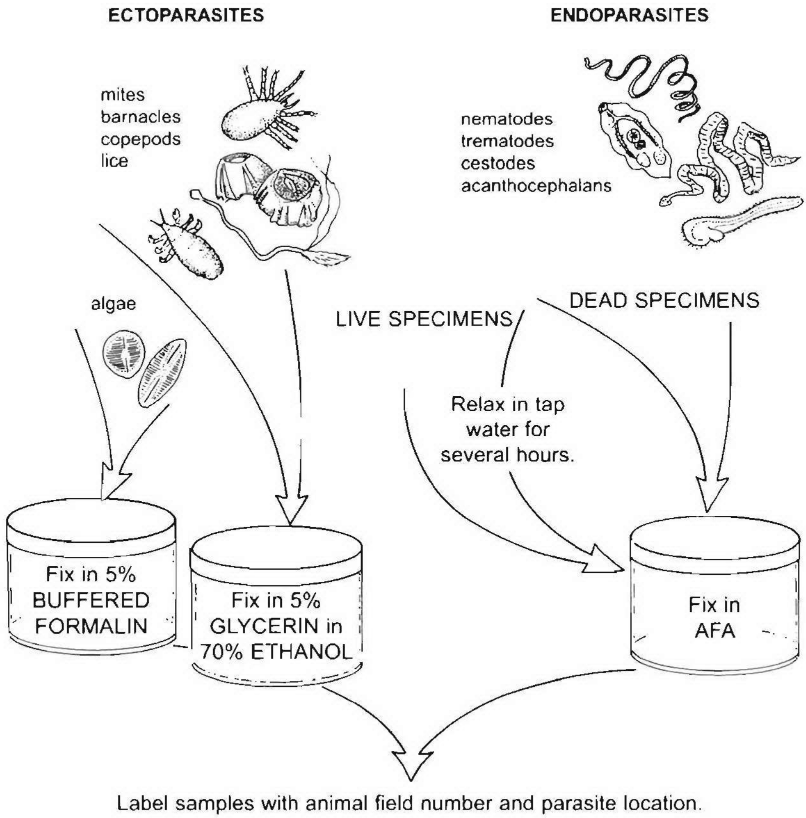


Fig. 10.32. Basic field protocol for preserving parasites.

Ideal

All parasites are collected intact for identification and counting, along with samples of associated infected tissue. Location and intensity are recorded and lesions photographed. Samples are fixed in an appropriate medium and labeled with the animal identification number and anatomic or tissue site of origin.

Practical

Collecting parasites is simple and straightforward but requires patience. A representative sample of intact parasites with samples of infected tissue, properly fixed and labeled, is a realistic goal.

Precautions

Remove parasites carefully, as they may be fragile and firmly attached to host tissue. Seal lice survive for some time on a carcass and can be transferred via clothing to seals in captivity. Whale lice can remain alive on a floating carcass for days. These lice can crawl onto investigators and cause a moderate rash[62].

10.13. SAMPLES FOR SKELETAL PREPARATIONS

Skulls and skeletons can be the ultimate key to identifying a species, determining physical maturity, and revealing abnormalities, injuries, or disease processes that affect bone. Skeletal materials can be prepared in the field or in the laboratory[30,66]. A small carcass (adult preferred) can be flensed, then placed in a mesh bag and buried under a meter of soil for about one month, or placed in a metal drum containing dermestid beetles, or soaked in a covered drum containing fresh or salt water until the remaining flesh is decomposed. The bones can then be boiled to remove the grease and bleached. Larger animals can be cut into sections (disarticulated), with each piece labeled, transported in a leak-proof container, and treated in a similar manner. Skeletons can also be prepared by composting a carcass (*see* **11.5**), or by placing it inside a cage with 0.5-cm holes and sinking it in the ocean, to be cleaned by amphipods. Large whales are normally buried deep enough to prevent disturbance and reduce risk to public health. Plotting the location helps investigators retrieve skeletons months or even years later. Proper safeguards are essential for carcasses that may present health risks to wildlife, whether through potential exposure to serious pathogens or ingestion of tissues contaminated by anthropogenic chemicals, including euthanasia solutions.

10.14. PERMITS, PACKAGING AND SHIPPING

Samples must reach the laboratory quickly, in good condition. A record of all samples, from their collection, through transport, analysis, and final disposition (i.e., **chain of custody** [*see* **14.2**]), is needed for any event involving legal action.

10.14.1. Packaging and Labeling

Package each specimen to comply with the appropriate protocol. Identify the sample clearly on both sides of the label in pencil or indelible ink. Preferably, "double-bag" (i.e., bag within a bag) tissue samples, placing a waterproof (and oil-proof) label in each bag printed with an indelible pen or soft pencil. For contaminant analysis, labels should not contact the tissues. Jars should be labeled on the outside, with a duplicate label inside. Never label lids only. Secure tags directly to voucher specimens such as skulls or mandibles; tag large items (e.g., skulls) in more than one location.

Include on the label:

- animal identification number
- species
- date, time (mm/dd/yy/military time), and location
- tissue

10.14.2. Shipping

Prepare shipments in a way that ensures the quality of the samples, prevents leakage on route, and protects the health and safety of the persons receiving them. Use sturdy, secure shipping containers. Protect samples from breaking, crushing, or deteriorating (e.g., thawing of frozen samples, or freezing of samples for bacteriology). Clean all surfaces of harmful substances (e.g., formalin). **Avoid shipping specimens in containers with large volumes of fluid.** Wrap bone specimens in protective paper or plastic, and pack in styrofoam chips. Transfer tissues fixed in formalin (for at least 24 hr) to containers with smaller amounts of formalin, saline, or 70% alcohol; or rinse well-fixed tissues with fresh preservative, wrap in cheesecloth or gauze (incontinence bed liners available at most department stores work well), moisten with preservative, and double-bag. Pack perishable samples layered with gel ice packs or dry ice (Fig. 10.33). Seal all containers with tape.

Print the name, address, and telephone numbers of both the shipper and receiver. Place a duplicate address label inside, along with all required documentation (i.e., loan form, permits, customs documents, and chain-of-custody forms). **Include a copy of the stranding report form** to provide pertinent information on species, size, sex, and observed pathologic conditions.

Be aware of current regulations concerning shipment of biological and hazardous substances (e.g., formalin) **and restricted coolants** (e.g., dry ice). Prepare forms, labels, permits, and documentation before taking material to the shipper. Arrange rapid transport (i.e., courier or air express), and **always arrange for pick-up at the destination before shipping perishable specimens**. Avoid shipping on a Friday or weekend. Once the samples are shipped, notify the receiver of the waybill or tracking number.

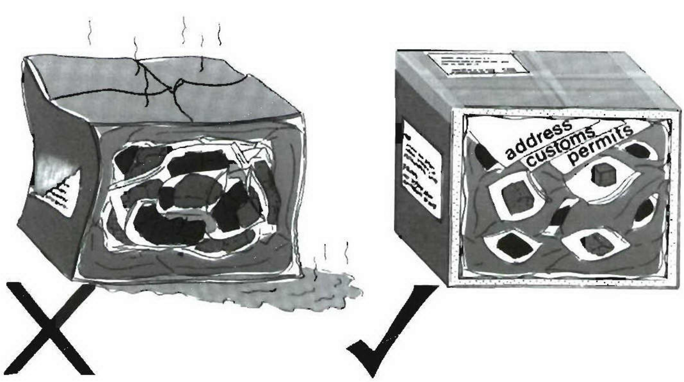


Fig. 10.33. Proper packaging is essential to protect frozen specimens. Use a well insulated container with liberal amounts of gel packs or dry ice interspersed among the tissues. Avoid using dry ice for samples for bacteriology.

Precautions

Samples arriving at their destination poorly identified or in bad condition are useless. **Ship perishable samples by the fastest possible route**, and request a "same day delivery" label to expedite service. **Consider the day of the week specimens will arrive at their destination before shipping, planning so that parcels arrive when they can be unpacked immediately—this is essential for frozen tissue.** Clearly indicate on the package the day and evening telephone numbers of the recipient. Increased airline security restrictions can result in confiscated equipment and samples. Plan ahead, and investigate ground transportation options. When air travel is required, try to arrange direct flights, avoid airports where long delays are common, and, if possible, package specimens in small carry-on containers. Days of toil have been lost by samples gone astray with errant luggage.

10.14.3. Permits

In the U.S., authorization is needed (i.e., by NMFS or FWS) to collect, ship, and receive samples from stranded marine mammals[111]. Some activities require additional permits. CITES (Convention on the International Trade of Endangered Species) permits are required for importing and exporting samples from species listed in CITES Appendix I, and export permits only for species listed in CITES Appendix II[23]. Importing samples into the U.S. also requires a permit from the U.S. Department of Agriculture, Animal & Plant Health Inspection Service. In the U.S., regional coordinators or qualified laboratories may be covered under a blanket permit issued to the NOAA Marine Mammal Health and Stranding Response Program. Understanding the regulations will save a lot of time and keep you out of trouble!

Box 10.5. Environmental Samples and Data

General considerations

Large-scale mortalities are sometimes linked to environmental change or disturbance. Understanding the nature of these conditions can help pinpoint the cause. Environmental data may include:

- Global Positioning System (GPS) coordinates
- Air and water temperatures over the previous 4-6 weeks
- Wind and current patterns
- Salinities in affected areas
- Occurrence and distribution of algal blooms (species identification, cell counts, and toxin concentrations)
- Spills or discharges of toxic chemicals
- The health of other animal species in the affected area.

Note: real-time information on sea surface temperatures in U.S. waters can be obtained from the National Environmental Satellite, Data, and Information Service (NESDIS), Coast Watch Program (http://coastwatch.noaa.gov/cw_dataprod.html).

Water samples for toxic phytoplankton analysis[95,99]

Collect daily samples in areas where distressed or dead animals are found. Check with shellfish monitoring programs regarding shellfish bed closures. **Consult with the testing laboratory to confirm protocols.** (In the U.S., the NMFS Marine Biotoxins Program, Charleston, SC, coordinates sample collection, phytoplankton identification, and toxin analysis during unusual mortality events.) Portable equipment[94] makes it possible for skilled technicians to identify certain algae on site.

Collecting surface water samples

1. Collect surface water samples (from depth of ~0.5 m) in clean containers first rinsed with seawater from the sample location.
2. Carefully transfer some water into the sample bottle and rinse. Empty and refill without creating bubbles (some dinoflagellates are fragile.) Collect 500-mL to 1-L samples. Use brown plastic bottles for samples for brevetoxin.
3. Label bottles with collection date and time, specific location, depth, sampler's name, and other data if possible (e.g., water temperature, salinity, dissolved oxygen, tide stage, and wind direction).
4. Keep bottles between 17° and 27°C and away from direct sunlight. Wrap in wet paper; place in cooler for transport. Do not place live samples on ice.
5. If live material cannot be processed in the laboratory within 24 hr, add Lugol's solution (*below*) at a concentration of 5 mL per 1 L of water at the time of sample collection. Store in amber glass or brown plastic bottles or jars, under cool (preferably refrigerated), dark conditions.

    Unacidified Lugol's solution:

    50 g KI (potassium iodide)
    De-ionized water
    25 g I_2 (elemental iodine)

    Dissolve 50 g KI in 100 mL de-ionized water; add 25 g I_2 and dissolve.
    Add de-ionized water to make 500 mL.

(*continued*)

Box 10.5. Environmental Samples and Data (*continued*)

Samples from other species[95]

Other species in the area can provide clues to the presence of biotoxins[41,52]. Filter-feeding fish and invertebrates can accumulate and retain some toxins for weeks or months after a bloom has disappeared[9]. Analyze species from areas subject to blooms to determine background levels. During an unusual event, collect about 1 gallon of **whole or live invertebrates** in a clean container without water, seal with tape, and store in double plastic bags. Ship without ice to the laboratory within 24 hr. If samples are held more than 24 hr, freeze before sending to the laboratory.

Collect both **freshly dead and healthy fish** from areas of fish kills. Double bag individual fish, label, wrap in newspaper, and place on ice. Pack in a hard-sided cooler and ship to the lab by the fastest means available.

Samples for microbiological analysis[3]

Water samples for microbiological analysis can be collected when the cause of death or illness is unknown or of suspected microbial origin, or in areas contaminated by wastewater.

Collect samples in wide-mouth bottles (at least 120-mL capacity) or plastic bags that have been cleaned and rinsed carefully, rinsed with distilled water, and then sterilized.

1. Keep bottle closed until it is filled.
2. Obtain samples from beneath the surface and from the upstream side of a boat. Avoid contact with shorelines, bottom sediments, debris, etc.
3. Fill container without rinsing, leaving at least a 2.5-cm air space; replace cap immediately.
4. Place samples in cooler with gel freezer packs to minimize changes in types and numbers of bacteria.
5. Transport to laboratory for analysis as soon as possible.

Samples for contaminant analysis

For organic contaminants, collect a minimum of 1 L of **water** in brown glass jars (with Teflon-lined lids) washed with pesticide-residue-grade solvent. For heavy metals analysis, collect (minimum 500 mL) samples in acid-washed and rinsed plastic jars.

1. Allow nothing but the water sample to contact the inside of the jar or lid.
2. Collect water from the upstream side of the boat or upstream from the sampler's hands; avoid debris.
3. Immerse jar just below the surface; fill twice and empty; then fill and save contents.
4. Pack in cooler with gel freezer packs for transport to laboratory; keep in the dark and do not freeze.

Sediment samples for contaminant analysis must be collected with the same care.

1. Collect samples in a cleaned (minimum size 250 g) wide-mouth glass jar for organic contaminants and in a plastic jar for metals (prepared as above).
2. Fill jar 3/4 full by scraping jar mouth along top 1 cm of sediment; use jar lid to help secure sample. Only the sediment sample should contact the inside of the jar or lid.
3. Place jars in cooler with gel freezer packs for transport to laboratory. Ship samples within 24 hr or freeze.

Laboratory Contact Information:

Notes:

Chapter 11
Carcass Disposal

"That whale is here. We have seen him and smelled him. We are wiser for it, because we have had a 'most practical lesson in natural history'...The whale is composed of several parts...There is the blubber, and the whalebone and—the smell. The latter seems to be the most prominent feature of this whale."[25]

The simplest way for a carcass to disappear is to turn your back on it and walk away. That approach is fine in remote areas, but what if the scene is a bathing beach or someone's backyard? Soon after the novelty wears off, all but the most resolute scientist will be clamoring for the carcass to vanish. Who is responsible for it then? Perhaps the community or homeowner at first. But as we all learn sooner or later, the attitude is "you cut it, you own it", and the stranding team may find itself burdened with the fragrant remains.

How the team accomplishes the task of disposal will depend on circumstances, including local law and culture, as well as available equipment, coastal geography and currents, and the type and number of carcasses involved. In the U.S., some states have guidelines for disposal; in other areas, networks are encouraged to work with specific state or local agencies with jurisdiction over beach areas[27].

The Operations Center should **develop disposal plans in advance** to avoid headaches and unexpected expenses. This is particularly important in areas of dense human population, where getting rid of the carcass is top priority. And on the way to a landfill, don't expect people to rejoice as you cart a fetid carcass through town. Nurture relationships with officials at state parks, military bases, and wildlife refuges. Such sites may offer safe and sanitary conditions for a thorough necropsy. In areas where floating whales may need to be towed to shore for necropsy (e.g., right whales), plan ahead to identify areas that meet the necessary requirements (e.g., water depth and heavy equipment access), and develop protocols for the team to follow.

While a decision and preparations are underway, take steps to secure the carcass—from a tide that may carry it into a shipping lane, from dogs and other scavengers that might be exposed to infectious disease or toxic agents used in euthanasia, and from interference by the public.

Interspersed with more practical advice in this chapter are descriptions of some often-attempted but not always successful ways of getting the job done, presented with the help of colleagues who have recounted for us some of their best and worst experiences.

Box 11.1. A Real Crowd Pleaser

Tom Murphy[18] was trying to dispose of a dead humpback whale that stranded directly in front of a ritzy hotel on Hilton Head Island, South Carolina..."*We contacted the Charleston Museum, which asked that we salvage the skeleton. The maintenance department quickly produced a bulldozer and an earthmover to drag the carcass to an undeveloped section of beach for temporary burial. As the two pieces of equipment pulled in tandem, they began to disappear in the soft sand while the whale remained firmly in place. I then suggested we cut the whale in half to simplify the job, and was offered a chain saw to speed up the operation. It cranked with the first pull and I climbed atop the whale to a position just behind the skull. By this time it was early evening and a large crowd had gathered, everyone with cocktails in hand. As the saw penetrated the blubber, I immediately realized that while the exterior looked fresh, the inside was soup. The chain saw drove deep into the liquefied entrails and produced a spray that plastered my legs and boots and then arched some 30 feet across the beach. As the sight and odor made its impact on the crowd, every martini got dumped onto the sand. The reality of a stranding event took over and the ambiance of the entire afternoon suddenly changed.*"

11.1. LET IT LIE

Leave it where it is and let weather, tide, and scavengers do the work. This is a common practice in uninhabited areas where there is no concern about a smelly mess or public health hazard. The process is fast; eight mature humpback whales left exposed on the tidal flats of Cape Cod after a December 1987 stranding were reduced to inconsequential remains by summer.

Box 11.2. Human Scavengers

Peter Best[2], from South Africa, reminds us that in some parts of the world a carcass, for all its scientific value, is still a good source of food. "*A straggler from a mass stranding of Risso's dolphins was left rolling in the surf while rescue teams struggled elsewhere with the main body of the animals. Returning six hours later, all that could be found was one flipper and a skull minus the lower jaw, still attached to a spotlessly cleaned portion of the rib cage.*"

Before the Marine Mammal Protection Act, stranded animals in the United States were used to supplement lean larders. That was Bill Perrin's[21] response to a nude bather's desire to know if the meat from a whale he was examining was safe "for her dog." "*Good,*" *she said as she, together with her unclad husband, piled 50 pounds or so onto a piece of plywood. Bill recalls, "The board was limber and the meat bounced...everything bounced.*"

Before turning away from the carcass, extract tusks, baleen, or teeth to protect any souvenir hunter from unknowingly running afoul of the law. Also open the abdomen and thorax. This will prevent any bloater decomposing in the hot sun from becoming the subject of another messy explosion story. Be especially careful when cutting open large whales.

> Box 11.3. Taking the Plunge
>
> Bob Bonde[3] tells us about a salvage worker who was stripping back the skin of a 50-foot sperm whale..."*The fellow was standing on the carcass making cuts with a 6-foot Norwegian flensing knife when he disappeared. A 'splosh' was heard, then muffled cries for help. His mates ran around the whale, but alas could not find their friend. Finally, a gooey, dripping mess emerged covered from head to toe in oil; the fellow had fallen entirely into the massive junk case in the whale's head. He said it took two weeks to purge himself of the smell, but his close friends, noses hoisted, confess he's never completely gotten rid of it.*"

Another reason for opening a carcass is so that it will sink in the event the surf steals it back to the sea. A bloated whale floats high on its back, the dorsal fin acting like a keel, as it sails before the wind like a 10-meter yacht. These "floaters," as they are called, can cause endless confusion as they are rediscovered, renumbered, and relocated.

> Box 11.4. Fat Floats
>
> It's amazing how long a carcass can continue touring the beaches. Jim Mead[14] and one of the authors (JRG) once responded to the stranding of a 10-meter-long right whale on Monomoy Island, Cape Cod, that had already lost most of the epidermis through decay. The carcass answered the first incision with a gush of liquid innards; the afternoon tide then carried the remains back to sea. Jim's logbook tells the rest of the story..."*Five weeks later, I responded to a call about a whale hung up on an offshore rock near Buzzards' Bay, on the Cape. We managed to get out to it by rowboat and, lo and behold, it was the Monomoy right whale, which in 5 weeks had drifted 15 miles to the west. In the meantime, it had lost all of its flesh and bones and what we had before us was just a blubber blanket. Two days later, the blubber made its way to Craigville Beach, a popular bathing resort. Details of the ultimate disposal (at sea) are lacking because the fisheries agent involved turned out to have spent some time on a submerged rock when the police launch in which he was riding sank.*"

When leaving a carcass to decompose naturally, consider whether doing so would expose scavengers to transmissible diseases, toxins, or other harmful substances, including high concentrations of chemical agents used for euthanasia[7]. **Carcasses that present a potential hazard to public or animal health should be properly buried, taken to a sanitary landfill, composted, or destroyed by incineration.**

Box 11.5. Does Size Make a Difference?

Do small pieces decompose sooner than whole animals? Greg Early[5] and Bob Prescott had some unexpected results one winter on a marsh. Hoping to minimize any ecological damage caused by large carcasses, they scattered small cut sections from 60 pilot whales over a large area of bog and sunk the heads deep into salt-marsh pools. About a dozen carcasses were simply opened and left alone. By spring the intact carcasses had virtually decomposed, and the underlying marsh grass was well on its way to recovery. Meanwhile, the scattered sections had polluted the pools and spoiled the surrounding vegetation, but were quite intact (testimony to the processes that yield mummified mammoths and bog-people). So too were the gaseous heads, which rose on one moon tide with their snouts turned to the night sky—a macabre sight the townsfolk have yet to forget.

11.2. BURY IT

Conventional wisdom suggests that a quick way to conceal a carcass and have it decompose is to bury it. This may be easier said than done. Burial of larger carcasses requires heavy equipment and experienced operators, and the site must be selected with care[19,27].

- The environmental damage and disturbance (e.g., to the beach, vegetation, dunes, nesting birds and other wildlife) caused by the equipment and the excavation must be trivial enough to justify the decision.
- The site must be accessible to heavy equipment and suitable for safe operation (e.g., not areas with soft sediments or rocky shorelines).
- The carcass can be buried deep enough to prevent it from being dug up by scavengers or exposed by erosion (e.g., well above the high tide line). Consider seasonal changes in beach sand deposition, as loss of sand during winter storms can uncover buried carcasses.
- The site is above the water table and in an area where body fluids will not leach into the groundwater.

Maintain good public relations and avoid costly unearthing and re-burial by first agreeing on a site and obtaining permission from local authorities. Complete all studies and sampling before the equipment arrives, because after the hole is dug, the remains will likely be buried, ready or not. Mark the site on maps used by the stranding network or record the GPS coordinates, so the carcass can be located later and to help prevent accidental recovery of previously buried carcasses.

Some public landfill sites and private operators accept animal carcasses. Be aware of regulations and local statutes, as well as regional landfill capacities. Establish a time of delivery (or for collection, if the carcass is small) and settle finances in advance: costs can be high for large whales or multiple carcasses. Advise the operators of any potential health risk (e.g., to scavengers), and bury under at least one or two meters of earth[23,27].

The rate of decomposition depends on the characteristics of the remains, depth of burial, the terrain, and water and air temperature. Decomposing fats produce most of the odors and are more difficult to deal with. A carcass that is rich with blubber will tend to rise in soft wet sand, even when split open and weighted down with tons of rocks. Four humpback whales that were buried in sandy beaches just below the tidal wash on the north shore of Cape Cod surfaced twice within a year and had to be reburied, and liquefying parts of others periodically emerged as sands shifted with tides and storms. Several carcasses that were only opened and left exposed had already deteriorated by that time. Bones buried too long may be degraded by anaerobic bacteria; a gray whale skeleton, for example, was severely eroded after 1.5 years of burial[9].

There may be occasions when you wish to retrieve a carcass that someone else has recently buried. Peter Best[2] notes that attempting to use a vehicle to drag a carcass out of an opened grave tail-first is frustratingly unsuccessful. For cetaceans up to the size of a beaked whale, he suggests tying a long rope to the tail, but then pulling (with the vehicle) from the head end of the grave. After a neat headstand, the carcass tends to flip over onto the beach.

Box 11.6. Use It or Lose It

Bob Brownell[4] meticulously dissected a pilot whale for later use as a skeleton, and buried it at the edge of the parking lot of the Cabrillo Beach Marine Museum in San Pedro, California..."*The next spring, without notice, the city's road department sent a work crew to improve the parking lot, which they did. They extended it, graded it, then paved it over—whale and all.*"

11.3. MOVE IT

When a carcass is a nuisance, hazard, or public health risk, it may be possible simply to shift it to a more appropriate site. Permission at one or more levels of government may be required for any transfer, especially across state lines. **Small or rare animals are often removed intact to a facility for further study or preservation.**

Large carcasses require heavy machinery. For estimating carcass weight, refer to figures 5.2 and 6.3. If equipment is not available or other conditions (e.g., soft sand) prevent moving the whole carcass, cutting it into pieces may be the only option, and that in itself can be a story.

Box 11.7. Getting There is Half the Fun

Floridians are especially protective of their manatees. While carting away a bloated carcass he retrieved from a lagoon, Dan Odell[20] was pursued by the Florida Marine Patrol and finally stopped by the Game and Freshwater Fish Commission for..."*transporting a pregnant manatee in the back of my truck. I didn't know how fortunate I was at the time; only later did I discover that the group reporting the 'robbery' had considered using firearms to stop us. I immediately had the words MANATEE RESEARCH painted in LARGE letters all over the vehicle.*"

Melissa Miller[16] recalled her own 'good plan gone wrong' as she was helping to transport a 1350-kg elephant seal carcass..."*After much deliberation, we decided to transport it on a flatbed truck to our facility for easier necropsy. On the way off the beach the flatbed truck tipped sideways in a streambed and got stuck, so we called AAA to tow us out. The driver was perhaps the most unflappable person I have ever seen. He hiked down to the truck, looked over the huge, bloated carcass draped across the back (with 3 of us sitting on top of it to provide counterweight to the tipping), and asked solemnly, 'Is it dead?'*"

Lena Measures'[15] hopes for an enlightening dissection of a fin whale were quickly dashed while preparing the remains to be moved to a landfill site..."*As the carcass slid past the roll-bars designed to prevent the load from rolling off the flatbed, the ribs of the fin whale began to hit the bars with a squeeze-cage effect. I shouted 'Whoa!' to the winch operator but too late! To my horror and the groans of bystanders, a great gushing sound preceded a sudden regurgitation into the harbour of torn internal organs through the fin whale's now wide-open mouth. I strained to identify the gaseous floating organs (definitely Code 3) in the filthy harbour water and briefly considered trying to collect them but decided I had neither the necessary heavy equipment nor a large enough container to hold them.*"

In 2004 the residents of Tainan, Taiwan, were treated to an unusual sight—a huge whale carcass carried along on a flatbed through the bustling city streets. Imagine their surprise when the entrails of a 60-ton sperm whale exploded, showering them, and everything in sight with the soupy remains[22].

11.4. TOW IT OUT TO SEA

A large carcass, or many small ones, can be towed out to sea, providing it is released far enough offshore so that currents and winds will not bring it back, it is clear of a shipping lane, and has enough ballast to sink it—this may amount to several tons[8,10]. The Coast Guard or harbor police may be willing to assist; it would be wise to consult them before making the attempt. Depending on the area, the towing distance required for safety may be 80 km or more[27]. Special permits may be required if the material used to sink the carcass is considered a contaminant to the environment.

In recent years, some researchers studying "whale falls"—the communities of strange creatures that thrive on the decaying carcasses of sunken whales—have started to collect and sink dead whales to create opportunities for accessible, controlled studies. Coordinating a disposal effort with such a group would be beneficial to all concerned, including the myriad benthic species that will soon take up residence[8,24].

Box 11.8. Into the Briny Deep

Helene Marsh[13] attempted to tow a dead minke whale head first. "*It's mouth opened and acted like some giant sea anchor. The trawler was going absolutely nowhere.*"

John Heyning[10] had better success hauling a 75-foot blue whale carcass out to sea, off Southern California, where it floated like a ghost ship..."*The skipper, before securing a line to the flukes, asked if it would take 1 or 2 tons of chain to sink it. I estimated that after 5 days in the July sun, gases of decomposition had more likely generated about 10 tons of buoyancy to overcome. I told the captain that even if his tug sank, it would only dangle from the bloated body. The skipper disregarded my warning, and for more than a month I received reports of a mangled whale carcass floating off Catalina Island with an enormous quantity of chain draped over its flukes.*"

A state park superintendent contacted Peter Howorth[11] for advice on dealing with a gray whale carcass lodged between pier pilings. The superintendent wondered if explosives would remove the unwanted park addition..."*I explained that using underwater explosives would require a lot of red tape, including environmental reviews, and that replacing the pilings would cost some $30,000 each—or more. A marine contractor friend explained that unbolting the piles where they were fastened to the pier would allow them to spring out enough for the whale to be pulled free by boat. The pilings could then be pulled back into place and bolted back to the pier. It worked like a charm, with the whale coming free with no fuss at all. Meanwhile, I tried to find a home for the specimen, but no one was interested in a gray whale skeleton. NMFS did help me find a researcher interested in finding out what organisms ate whales that sank in deep water...but financing was tight. At that point, BBC decided this would make an interesting segment for a documentary and bankrolled the towing job. A few weeks later, a video photographer descended in a submersible and filmed hagfish feeding on the carcass. So, the superintendent got rid of his problem at no expense, the scientist completed his research, and BBC got some fascinating footage for their special!*"

In 2002, 57 pilot whales stranded in Wellfleet, Massachusetts. Forty-six were refloated and a day later came back ashore. Most were dead; the others had to be euthanized. Being the hottest week of summer, no one wished to cart the baking corpses through town to the landfill. The team instead obtained a permit for disposal at sea. After two days of tugging carcasses off the mud flats, they were towed to deeper water and, in a novel move, the team secured the whales, in groups, by the tail stocks to "Jersey" barriers. The notion was that all would disappear into the deep and it would be over. Not so. Instead, what dotted the ocean surface were "odorous, gray bouquets of bloating flesh," each rooted by a suspended concrete barrier. In the end, the carcasses were cut open and degassed. The Jersey barriers did the rest and everything disappeared[26].

11.5. COMPOST IT

The livestock industry, faced with high costs of rendering carcasses, concerns for disease, and the adverse effects of burial and incineration on groundwater and air quality, is turning to composting. Carcasses are placed in a composting bin and covered with a "bulking agent," such as sawdust or straw, that is high in carbon. As anaerobic microorganisms break down the carcass, fluids and odorous gases diffuse into the bulking material, where they degrade to carbon dioxide and water. A properly functioning composting unit requires minimal maintenance, emits little odor, has no effect on groundwater, can operate year round, and reaches internal

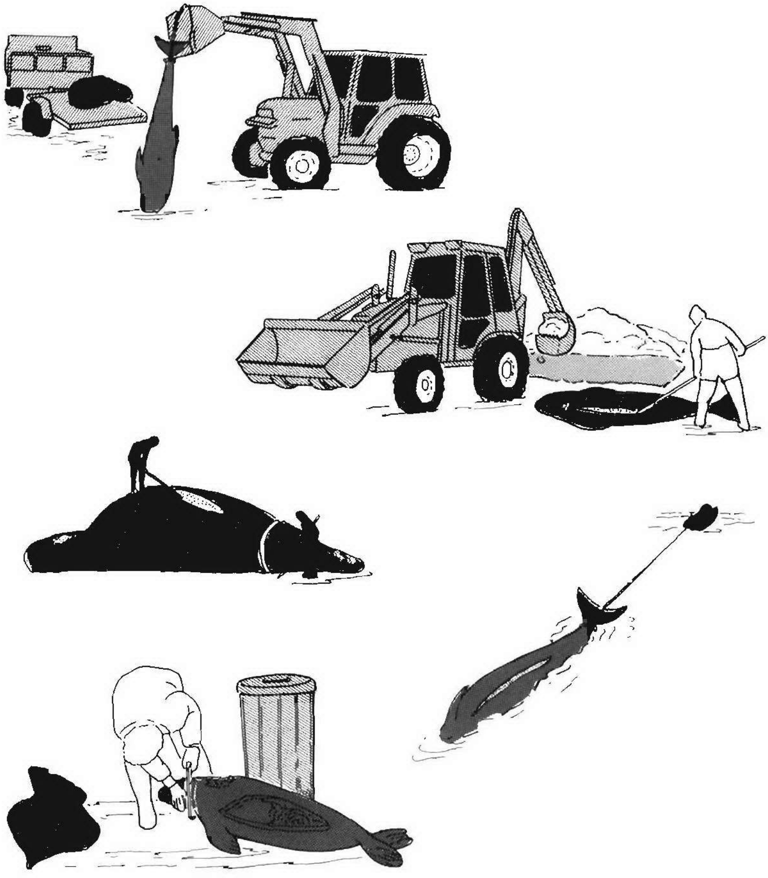


Fig. 11.1. Various methods of carcass disposal, including moving to an alternate site, burial (after opening body cavity), cutting into smaller pieces for disposal, and towing out to sea (after opening body cavity). Choose a method that minimizes health risks to the public, other species, and the environment.

temperatures high enough to kill pathogens[17] and break down chemical euthanasia agents[6]. Detailed guidelines for constructing and operating composting units for carcasses up to about 640 kg are available from the Minnesota Department of Agriculture[17]. Check with local authorities and agricultural agencies for guidance and any necessary permits.

11.6. RENDER IT

Some rendering plants and commercial incinerators may accept marine mammals. The drop in the number of rendering companies in many areas and increasing costs may preclude this as an option[6]. Disposal by rendering may require arrangements with federal and local authorities[27].

11.7. BLOW IT UP

It might seem logical to blow up a carcass, theoretically at least, into tiny pieces that no one will notice or care much about. The use of explosives will require experts in their use and numerous permits. Experience would argue against this method of disposal on the beach. In any case, move bystanders far away (probably farther than expected) from the carcass.

Box 11.9. What Were They Thinking?

Explosives were tried once with a 14-meter, 8-ton whale in Oregon. This story, which is dismissed by some as urban legend, is on videotape taken by Ron Finn, which can be found on the Internet. Equally vivid is Dave Barry's[1] animated description of the event.

"The responsibility for getting rid of the carcass was placed upon the Oregon State Highway Division, apparently on the theory that highways and whales are very similar in the sense of being large objects. So anyway, the highway engineers hit upon the plan—remember, I am not making this up—of blowing up the whale with dynamite. The thinking here was that the whale would be blown into small pieces, which would be eaten by seagulls, and that would be that. A textbook whale removal.

So they moved the spectators back up the beach, put a half-ton of dynamite next to the whale, and set it off. I am probably guilty of understatement when I say that what follows, on the videotape, is the most wonderful event in the history of the universe. First you see the whale carcass disappear in a huge blast of smoke and flame. Then you hear the happy spectators shouting 'Yayy!' and 'Wheee!' Then, suddenly, the crowd's tone changes. You hear a new sound, the sound of many objects hitting the ground with a noise that sounds like 'splud.' You hear a woman's voice shouting 'Here comes pieces of ...my GOD!' Something smears the camera lens.

Later, the reporter explains: 'The humor of the entire situation suddenly gave way to a run for survival as huge chunks of whale blubber fell everywhere.' One piece caved in the roof of a car parked more than a quarter of a mile away. Remaining on the beach were several rotting whale sectors the size of condominium units. There was no sign of the seagulls, who had no doubt permanently relocated to Brazil."

11.8. BURN IT

When carcasses are fresh and plenty of fuel is available, burning may be an option. In most areas, this will require a permit. Take into account the potential risks—contamination from burned fuels, wildfires in areas with significant vegetation, and anger of local residents if anything goes wrong (e.g., leaving an unbelievable mess). Consider other alternatives.

Box 11.10. Up in Smoke

After deliberating on how to dispose of 500 tons of stranded sperm whales in Florence, Oregon, in June 1979, the decision was made to burn the carcasses, at an unforeseen cost to the state of $25,000. Bulldozers were used to push the carcasses into large pits dug in the shore. As told by Barry Lopez[12], ...“*the whales were ignited in pits—(it would finally be done with thousands of automobile and truck tires, cordwood, diesel fuel, and Alumagel)—as they burned they were rendered, and when their oil caught fire they began to boil in it. The seething roar was muffled by a steady offshore breeze; the oily black smoke drifted over the dunes—thinned until it disappeared against a weak blue sky.*”

11.9. AFTERWARD

After every stranding, all equipment must be properly cleaned and sterilized. Soak clothing in detergent with disinfectant and wash separately from other laundry. (For big jobs, consider wearing old clothing under protective outerwear you can discard when you're done.) No matter what you do or wear while working on a carcass, you are bound to contact oils with lingering qualities—a fact to consider as you plan the remainder of your day's activities.

Box 11.11. The Lingering Evidence

Bob Bonde[3] worked on a right whale calf in Georgia...“*with a friend who does not believe in gloves and gets some perverse pleasure out of absorbing odors from dead creatures through his hands. That night we returned to Florida and put away the valuable skeleton. After washing up with everything from ammonia to bleach to mouthwash, we decided to go to one of the University sporting events. Unfortunately, it was a sell-out game and we had to sit in close quarters. Occasionally, I would get a slight whiff of 'dead whale smell' and check my fingers. Not me. Soon, however, I noticed others in the stands smelling their hands too, squinching up their noses, stirring nervously and searching the soles of their shoes—telltale signs of annoying smells in a large crowd. We went home early that night, thankful that no one had found the source.*”

11.10. CONCLUSION

The best way to deal with a carcass is to bury, compost, remove, render, or tow and sink it. Few large-scale disposal operations will turn out as planned. It seems that for the near future at least, any advances to overcome these problems will continue to develop at a slower pace than the memorable stories of what went wrong.

Chapter 12
Health and Safety Risks

12.1. HAZARDS TO THE PUBLIC

A stranding scene is a good place to disregard any popular notions that marine mammals are playful and friendly. By definition, a stranded animal is in trouble. With that, its behavior is unpredictable, and normally docile species may be frightened enough to attack. Even experienced persons have been seriously hurt by the thrashing flukes of a struggling whale or the unexpected rolling of a manatee. Pinnipeds and sea otters can inflict serious bite wounds that can become infected. **The public must be informed and reminded that these are wild animals: keep children and pets away.** The risks increase for those unfamiliar with the species' behavior and untrained in rescue procedures. Apart from injury is the potential for infectious agents to be transmitted from these animals to anyone coming into physical contact with them. Those who might view a stranded animal as edible should be cautioned that even apparently healthy animals can be a source of trichinellosis[26,28] (a parasitic infection) and harmful toxins from bacteria such as *Salmonella* and *Clostridium*[1,2,70]. In some coastal areas, coyotes and other predators may aggressively defend their rights to a stranded animal or beached carcass; humans approaching too closely may risk serious injury, including exposure to rabies.

Other public health issues arise during unusual mortality events, such as concerns for infectious disease or environmental toxins. Many of these issues are best addressed by responsible reporting and through public education. Risks to the public, including disease transmission, can be avoided by establishing a safe boundary within which only the response team should operate. This can be accomplished and still satisfy the inevitable curiosity of onlookers (*see* **3.3**).

Failure to take appropriate action may be viewed as inattention to public safety, forcing others in authority to take charge. At one long-ago winter stranding on Cape Cod (Massachusetts), live pilot whales struggling on the beach and in the surf drew a large crowd. While some people futilely attempted to drag or roll the animals into the water, others climbed on the whales and hoisted children onto them for photographs. To prevent human injuries, local officials chose to drag the live animals by their tails overland to a secure area. All of the whales died, some during the move and others while they were unattended at the secondary site.

Such scenes can be avoided by good planning—to protect both public health and animal well-being—and rapid disposal of carcasses (*see* Chap. 11). Take advantage of opportunities for public education in the form of posters or pamphlets dealing with these issues (*see* **3.2.2**).

12.2. HAZARDS TO THE TEAM

12.2.1. General Considerations

Team members responding to a stranding face situations that can be risky, although less so than many leisure-time sporting activities. A person might be struck by a whale's flukes with appalling force, raked by teeth, rolled upon, or knocked into the surf; suffer sunstroke or hypothermia, aches, strains, and bruises; catch a face-full of blowhole discharge; or risk cuts by instruments and bone fragments. Still, relatively few serious injuries or illnesses have been reported as a result of working with stranded animals. **The greater the team's experience, training, coordination, and regard for safety, the less the likelihood of an accident.** Do not attempt rescues that are unduly hazardous (e.g., pinnipdes on ice).

Designating safety and staff support coordinators (*see* **2.6.3**) at strandings involving numerous volunteers will help protect the team from overexertion and reckless action. Providing adequate support will also diminish the chance of injuries. Fatigue and other discomforts—as result from drinking too much coffee when no facilities are available, wearing wet and gritty clothing, or being hungry—can reduce morale and concentration and thus increase the risk of accidents. The longer the operation or the more adverse the environmental conditions, the greater the need for essential comforts.

12.2.2. Transmissible Disease

Marine mammals, both healthy and ill, harbor a variety of bacteria, viruses, fungi, and parasites. Some of these organisms are zoonotic (i.e., capable of being transferred to humans) and have been transmitted from live marine mammals and carcasses[20,32,44,70]. Some diseases are acquired by eating raw or undercooked tissue[28] or accidentally ingesting contaminated feces[46,70]; common sense can prevent those conditions.

More important are agents that can be transmitted through direct contact with aerosols, tissues, or body fluids of infected animals. Among others, these include avian influenza virus, seal poxvirus, calicivirus (San Miguel sea lion virus), *Mycoplasma* spp., *Mycobacterium* spp., *Erysipelothrix* sp., *Leptospira* sp., and *Brucella* spp. (*see* Box 12.1). For most of these pathogens, reports of human illness attributed to contact with marine mammals are rare. Other organisms that

commonly infect marine mammals, such as *Vibrio* spp.[12,30,69], *Salmonella* spp.[2,4], and *Clostridium* sp.[1,13], while not reported as marine mammal zoonoses, are human pathogens and have the potential to cause disease.

The number of potentially zoonotic diseases reported in marine mammals continues to grow. Some pathogens may represent new or emerging diseases in marine populations[51], while other "discoveries" reflect growing intensity of research and advances in pathogen isolation and identification. Additionally, more people are coming into direct contact with potentially infectious marine mammals, largely as a consequence of expanded stranding response programs worldwide.

Still, the risk of disease is low for persons who are healthy and free from medical conditions or medications (e.g., steroid hormones, immunosuppressive agents) that lower resistance to infection. While this is reassuring, it is also reasonable to **assume that any live or dead animal is a potential disease carrier and treat it as such** by taking the following precautions:

- Avoid contact with stranded animals, carcasses, tissues, or fluids if pregnant or immunosuppressed.
- Wear untorn gloves when handling animals, carcasses, tissues, or fluids.
- Wear waterproof outerwear to protect clothing from contamination.
- Cover wounds with protective dressings.
- Wear face and/or eye protection when appropriate, e.g., during necropsies and close contact with diseased animals (especially when pathogens transmissible through aerosols may be present, e.g., influenza, *Mycobacterium* of the tuberculosis complex).
- Wash exposed skin and clothing after handling animals (or use a hand sanitizer [e.g., Purell®] in the field until washing facilities are available).
- Seek immediate medical attention for bites, cuts, and other injuries; inform medical attendants of the source of the injury.
- Keep up-to-date with recommended vaccinations (e.g., **tentanus**, rabies may be warranted where coyotes prey on seals).
- Do not consume food or beverages in the vicinity of stranded animals or carcasses and then only after washing or using an appropriate hand sanitizer.

Any illness that develops after being exposed to marine mammals should be brought to the attention of a physician, preferably one familiar with conditions potentially transferable from these animals. Illness should also be reported to stranding network officials, who maintain records of physicians with such experience and record incidents for future reference.

As an added note, pets and other animals may be susceptible to infections carried by stranded marine mammals—and vice versa. A stranding scene or rehabilitation center is no place for the family dog!

Box 12.1. Selected Marine Mammal Zoonoses

The following are currently recognized zoonoses. Others are certain to be discovered. **Consult a physician** if you become ill during or after working with a stranded animal.

Bacteria

"Seal finger," historically a disease of seal hunters, may be the most common disease risk for pinniped handlers. Also known as "speck finger," the condition is believed to be caused by a ***Mycoplasma*** infection and is treated with high doses of **tetracycline**[3,6,36]. Pinnipeds, which may carry these organisms as part of the normal oral flora[47], and possibly polar bears, are the only known carriers[6]. In humans, disease consists of swelling and severe pain, especially in the joints of the hand, beginning a few days after a bite or exposure of pre-existing wounds to contaminated tissues or secretions from infected pinnipeds.

A similar condition is caused by ***Erysipelothrix*** sp., which causes erysipelas in cetaceans and erysipeloid in humans. This organism is widespread in the environment and can persist for months in decaying or refrigerated tissues. Human infection is uncommon[11]; most cases result from handling fish or marine invertebrates, or materials contaminated by them. A few cases have followed contact with cetacean carcasses during necropsy and bite wounds from infected animals[32,66]. Infection mostly causes localized skin lesions, rarely serious disease, and is responsive to **penicillin** (or cephalosporin for those allergic to penicillin)[11].

Recognizing the difference between *Mycoplasma* and *Erysipelothrix* infections is important, since the treatment for one is ineffective against the other.

Mycobacteria of the tuberculosis complex (*M. bovis, M. tuberculosis*) are gaining attention. Following an outbreak in captive otariids in Australia, *Mycobacterium* sp. infection was found to be endemic in several otariid populations in the Southern Hemisphere (*see* **5.2.1**). The organism's zoonotic potential was confirmed when a seal handler developed pulmonary tuberculosis caused by the same strain[68]. These mycobacteria are generally transmitted through inhalation of aerosols from an infected host. Infected otariids may shed the organism in both sputum and feces, promoting transmission through contamination of skin abrasions or bite wounds[18]. People working closely with animals from infected populations should **limit close contact, take strict precautions, and undergo routine screening for mycobacteriosis**[41].

(*continued on page 246*)

12.2.3. Exposure to Heat and Cold

Workers on the beach normally protect themselves against overexposure to sun and heat by wearing proper clothing, using sun-screening agents, temporarily escaping into shade, and liberally drinking fluids. **Hyperthermia** (heatstroke) can be a problem on a hot beach but is generally avoidable when these common sense precautions are observed.

Hypothermia threatens persons who are wet and wind-chilled, or working in the water where heat is quickly lost to the surroundings. The earliest indication of cold stress is shivering, which occurs when body temperature is reduced by as little as 1° to 2°C. Eventual effects include skin reactions, allergic responses, and

reduced blood pressure, heart rate, and kidney function[5,38]. Persons may appear confused, sluggish, and disoriented, and perhaps believe they are still physically able to work. Allowing them to do so can place other team members at risk.

Prolonged exposure to cold air and water and reduced activity—precisely the circumstances encountered when rescuers must support animals in shallow water for prolonged periods—promote hypothermia. Going without food, or indulging in alcohol or drugs, can amplify the effects[5] in addition to impairing judgment.

Workers must be protected against the cold with adequate clothing (layering is best, with at least one complete change of clothing available), waterproof outerwear, gloves, and boots. Special gear must be worn by personnel working in the water for any prolonged exposure at temperatures less than 30° to 32°C. Windsurfing suits offer some protection for brief periods of immersion. Wet suits work best for people who are literally up to their necks in water by actively heating the insulating water layer. The neoprene also provides buoyancy, which is useful when trying to keep animals at the surface. Dry suits are superior for persons standing still for long periods.

Establish a rotation schedule for personnel holding animals in the water, and set limits on the time that any individual can be in the water in one day. Exposure times will vary, depending on ambient temperatures and how well the crew is dressed and equipped. As a general rule, a worker in a dry suit can spend twice as long in the water as one in a wet suit. Recovery time afterward is generally double the exposure time.

Meeting personnel needs for a comfortable rotation schedule may not always be possible even for a small stranding response. Consider a situation where the "in-water" time is limited to one hour, and 5 persons are required to hold each whale. Holding 10 whales for five hours would require 250 people if no staff were rotated, or 150 people rotated on a schedule of one-hour on, two-hours off. If adequate personnel cannot be enlisted, the response team must resist the temptation to "stretch themselves."

Box 12.1. Selected Zoonoses (*continued*)

Some **non-tuberculosis species of mycobacteria** have zoonotic potential[42]. *M. marinum* is common in marine environments. Infection in humans, typically affecting the hands, is generally acquired through exposure to infected fish or contaminated aquarium water. One human case, resulting from a dolphin bite, has been reported[25]. Other mycobacteria have been documented in marine mammals[7,75] with no reports of associated human infection.

***Brucella* infection** occurs in many pinniped and cetacean populations (*see* **5.2.1** and **6.2.1**). The organisms, host-adapted with a long history in the marine environment[29], cause clinical infection in some cetaceans (reproductive failure and other lesions)[23]. *Brucella* has not been associated with disease in pinnipeds[27,43], but seal brucellae did cause abortion in experimentally infected cattle[59]. Only one case of human infection has been reported, in a researcher working with marine *Brucella* isolates who reported flu-like symptoms lasting about one week[10]. However, studies suggest that marine brucellae can cause disease in humans[64] and that mild illness may be underreported[72]. Persons handling multiple carcasses from widely infected populations[72] or reproductive tissues and fluids from infected animals[23] should take extra precautions; pregnant workers should avoid contact with animals and tissues.

Leptospirosis, a common disease in terrestrial mammals[24], is caused by numerous serovars (strains) of the spirochete *Leptospira interrogans*. Signs include fever, jaundice, renal damage, and abortion. Transmission occurs through contact with urine or infected tissues or body fluids. Periodic outbreaks in California sea lions, and disease in northern fur seals (*see* **5.2.1**), is caused by the *L. interrogans* serovar *pomona*. A few cases of mild human illness have been reported following exposure to tissues or fluids from infected sea lions[34]. *L. interrogans* serovar *grippotyphosa*, also pathogenic to humans[24], has been cultured from Pacific harbor seals with leptospirosis[65]. The apparent absence of this disease in marine mammal handlers suggests that zoonotic transmission—or at least recognizable illness—is rare.

(*continued*)

12.2.4. Injury

Strandings afford numerous opportunities for injury. Moving along slippery shorelines, lifting or rolling large animals, and working with heavy equipment all present hazards to team members, particularly to those inattentive to the risks. Little can be done to make a stranding site safer, other than to mark off obstacles such as holes, or bring in spotlights (or use car headlights) and ensure all personnel carry chemical lights or other means of illumination when the work carries on into the night. **The designated safety officer should be on the lookout for potentially dangerous conditions or practices, and take appropriate action to reduce the chance of human injury.**

Water rescues require extra training and vigilance, as capture nets and poles can be wrenched forcefully aside by a struggling animal, lines or nets caught in boat propellers, and rescuers themselves entangled. **Extensive practice with equipment is essential. All personnel should wear life jackets and/or wetsuits; safety helmets add further protection during hazardous rescues.**

Box 12.1. Selected Zoonoses (*continued*)

Viruses

Influenza is one of the few viruses with documented transmission from marine mammals to humans. Several investigators working on an avian influenza outbreak in harbor seals in the late 1970s developed conjunctivitis caused by the same virus[74]. More recently, influenza B, a known human pathogen, was isolated from seals in Europe; the significance for handlers is unknown[56]. At least one pinniped **poxvirus**—a parapox virus that typically causes raised nodules on the head, neck, and flippers of infected animals—can cause painful, nodular skin lesions in humans that take several months to heal[39]. Marine **caliciviruses** (e.g., San Miguel sea lion virus [SMSV]) infect a wide range of species in the North Pacific[61,63]. Disease in California sea lions and northern fur seals is associated primarily with vesicular lesions of the mouth and flippers[61,71]. One laboratory worker exposed to SMSV-5 developed systemic illness and blisters on the hands and feet[62].

Other viruses are of potential concern. **Rabies** has been confirmed once to date in a marine mammal—in a ringed seal from Svalbard[53]. However, the rabies virus infects many terrestrial mammals; its potential to infect marine species should not be discounted, especially those that haul out in areas where the disease is common. **West Nile virus** (WNV), an arthropod-borne virus pathogenic to birds and some mammals, including humans[45], is generally transmitted through the bite of infected mosquitoes. However, human cases have resulted from contact with tissues and fluids of infected birds[16] and through intrauterine infection[15]. Harbor seals appear to be susceptible to infection (*see* **5.2.1**). Although unlikely to acquire infection from other mammals[45], personnel should take extra precautions when working with any animal in which WNV infection is suspected.

Fungi

Numerous fungal infections have been diagnosed in marine mammals[40,49,58], but the risk to healthy humans is low. The fungus ***Lacazia loboi*** (formerly *Loboa loboi*) is known to cause skin disease in humans in Central and South America and in bottlenose dolphins from Florida and Brazil[9,19,37], and has been reported in a dolphin (*Sotalia*) from Suriname[22]. One case of possible transfer of **Lobo's disease** to a handler from a dolphin has been reported[67]. A single case of human skin infection with ***Blastomyces*** also has been reported, apparently following exposure to an infected captive dolphin[14].

Parasites

Parasites of marine mammals generally pose little risk to human handlers. Most parasites have complex life cycles involving specific intermediate and final hosts. Human infections generally follow ingestion of raw or undercooked tissues (e.g., meat or blubber) or contaminated water or feces containing viable eggs, cysts, or larvae[46,70]. Fatal outbreaks of trichinellosis in humans[26,70] have been linked to ingestion of meat containing larvae of the nematode *Trichinella nativa*, a common parasite of some arctic mammals, including polar bears, walruses, and seals[28]. Toxoplasmosis, caused by the protozoan ***Toxoplasma gondii***, also can be acquired through ingestion of uncooked meat[31,70]. This parasite is reported in marine mammals with growing frequency (*see* **5.2.1**, **6.2.1**, **8.2.1**, and **9.2.1**). Other protozoans pathogenic in humans, including *Giardia* and *Cryptosporidium*, have been found in pinnipeds[21,46,54], although transfer from pinnipeds to humans has not been reported. Indeed, marine animals may acquire these parasites, as well as *Toxoplasma*, through ingestion of water, prey, or sediments contaminated by sewage and runoff[46,48,50,52].

Heavy lifting equipment is usually, but not always, in the hands of experienced operators who will ensure that the loads are properly secured. Even so, ropes may break or knots fail, and no one should be allowed to stand under an overhead load. Everyone must stay clear when dragging a carcass across a beach in case the line snaps. Lifting and moving an animal by hand is difficult enough under the best of circumstances: a brief delay to clear the path of obstacles or determine a safer route is time well spent.

In regions or situations where there is a risk of **shark attack**, do not enter the water to rescue or retrieve a dead or injured animal. Use a boat or work from shore (i.e., with a rope and grapple).

Never disregard the risk of **drowning**. Heavy surf and dangerous undertows can quickly turn an attempt to help into a personal tragedy. Except for actions along the shoreline, no one should enter the water unless there are boats or roped swimmers available to provide emergency assistance. Anyone working in the water after dark should wear a dry suit marked with a chemical light or other waterproof illumination device. At night or under rough conditions, at least one shore-based observer should be designated for each group of personnel in the water.

Procedures and equipment used for euthanizing animals can be hazardous to humans. **Firearms, drugs, and needles and syringes must remain in the possession of authorized individuals** who will take responsibility for their safe use (*see* **6.12**). Only those with the authority and expertise to do so may perform such actions; other personnel will best avoid danger by leaving the area completely.

Unusual events may require **aerial surveys**, which add another element of risk. The safety coordinator must ensure that team members comply with all safety regulations[76].

The basic equipment for a stranding response will include a first aid kit appropriately stocked to deal with cuts, abrasions, minor twists or sprains, and other routine injuries. The safety officer and site coordinator must know the location of nearby medical facilities, clinics, and hospitals in case of more serious mishaps. Police radios and mobile phones are the best way to summon an ambulance.

12.2.5. Exposure to Natural Toxins and Contaminants

Some stranding events, such as those involving natural toxins or anthropogenic contaminants, may require additional precautions. **Harmful algal blooms** are increasing in geographic distribution, frequency, and intensity[35]. While the primary risk to humans is through eating contaminated seafood, some toxins can cause irritation or illness through contact with skin or mucous membranes[73]. Brevetoxin, produced by the "red tide" dinoflagellate *Karenia brevis* (formerly *Gymnodinium*

breve[73]), is a potent neurotoxin. Florida manatees have died after ingesting toxin and inhaling toxic aerosols produced by wave action[8] (*see* **8.2.1**). Aerosolized brevetoxin can also cause severe eye and respiratory tract irritation in humans, with repeated exposure leading to hypersensitivity[57,60]. Persons with respiratory problems should either avoid activities in the water or along the shoreline when red-tide irritants are noticeable or wear an absorbent facemask to reduce exposure.

Other algal toxins with no role in a stranding might be dangerous for the team. For example, toxins produced by certain marine cyanobacteria (e.g., *Lyngbya majuscula*) can cause acute skin lesions in addition to skin, eye, and respiratory irritation[55]. Networks operating in areas where toxic blooms occur should provide educational material to team members and, if appropriate, develop specific protocols for working under these conditions.

Rescuing or salvaging marine mammals contaminated with **oil** or other materials presents additional health risks. The volatile components of petroleum that might irritate a marine mammal's skin, lungs, eyes, or mucous membranes can have the same effect on its rescuers[33]. If fumes are strong (i.e., the spill is fresh), the only safe option is to leave the area.

In the case of oil spills, the light, volatile fractions, which are the most toxic, generally evaporate within the first few hours or days after a spill[33]. Persons responding to an oiled marine mammal are more likely to encounter the heavier, less toxic petroleum residues. Working in these conditions requires training, authorization (*see* **2.2**), the full complement of protective clothing—including face and eye protection, and facilities for washing and obtaining clean clothing[17]. Anyone experiencing lightheadedness, respiratory irritation, or nausea should leave the area immediately, even if chemical fumes appear mild. Exposure of skin or eyes to petroleum or other chemicals requires immediate washing or flushing, respectively. Surfaces coated with oil—including rocks, tools, and the animals themselves—may be slippery or sticky, increasing the risk of accidents.

12.2.6. Die-Offs and Safety Issues

There are many potential causes of die-offs or unusual mortality events, from starvation or trauma to pathogens or toxins. The cause may be apparent at the outset (e.g., an oil spill) or remain undetermined until well into, or even after, the event. The responsible approach is to assume the potential for zoonotic disease: adhere to all guidelines for minimizing risk of disease transmission (*see* **12.2.2**), including face protection for those working with stranded animals or carcasses, and special arrangements for carcass disposal (*see* Chap. 11).

12.2.7. Injury Reporting and Liability

Accidents can occur in any field operation. Each stranding network should consult professionals to establish the legal framework for volunteers to operate (*see* **2.3.3**). The safety officer or site coordinator should document and track the outcome of all injuries. Such information may be essential if any injury results in legal action.

12.3. TRAIN AND PLAN FOR SAFETY

12.3.1. General Considerations

Training programs for stranding responders must include information on the hazards of the job and **stress personal safety** as the top priority. Injuries can be avoided through instruction on animal behavior and proper handling techniques (*see* **2.4.4**). Learning to recognize dangerous situations such as soft mud, heavy surf, or a beach of broken shells will prepare team members to take appropriate action. Accidents can be reduced by being aware of human limitations and setting realistic goals.

Assign tasks on the basis of training. People must not become involved in potentially hazardous duties (e.g., handling animals, taking samples from live animals, or working in the water) for which they are unqualified. The use of coded badges to indicate level and area of training will discourage this from happening, both on the part of the eager helper and on the part of the frustrated team leader desperate for another pair of hands.

Assignments also must take into consideration the availability of sufficient numbers of personnel for the task at hand, as determined by the safety officer or site coordinator. This is crucial when the response involves work in the water during cold weather. **When working in hazardous situations (e.g., heavy surf, cold water, or in darkness), organize workers in pairs (i.e., "buddy system") for additional safety.**

The effects of exposure and exhaustion are of primary importance for coordinators planning field schedules. During mass strandings or die-off investigations, develop a work schedule (e.g., 8 to 10 hours "in the field" followed by an 8- to 10-hour rest) tailored to meet environmental conditions. When field support is good, volunteers may wish to spend longer periods in the field, risking physical and mental fatigue.

One person (on rotation as appropriate) should keep track of the exposure time and rotation of workers, as the latter may be too busy to check this themselves—or too determined to remain on the job. In addition, the safety officer or assistants should watch personnel closely for early signs of hypothermia, particularly uncontrolled shivering. Anyone showing signs of shivering, stiffness, or lack of coordination should be required to return to the support center for a period of recovery.

12.3.2. Recognizing Limitations

Operations may need to be discontinued or plans modified if human safety is jeopardized. Attempts to carry or pull large animals with insufficient or fatigued personnel, or to continue work in the water after weather conditions become adverse, are just two situations where the response goal must be weighed against staff safety. Once the safety and site coordinators determine the best course of action, other team members and participants must comply with this decision. **At no point in the response effort can "blind heroism" be allowed to obscure rational judgment.**

Notes:

Chapter 13
Special Topics

13.1. DISENTANGLING MARINE MAMMALS

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13.1.1. General Considerations

Entanglements are the direct or indirect result of human activities. The urge to rescue entangled animals is strong and must be weighed against practical issues such as feasibility, likelihood of success, and the safety of the team. The decisions facing the response team must be based on the same criteria as for any stranded marine mammal (*see* Chap. 4): consider human safety first, and take no action that will only prolong the animal's suffering.

The response to stranded marine mammals entangled in nets or debris may differ little from the actions taken for animals that come ashore for other reasons (e.g., *see* **5.5** and **6.5**). In these cases, however, the ropes, nets, or other material must be removed in a manner that minimizes further injury to the animal and then carefully collected and documented. Depending on the animal's condition, the options may include immediate release, rehabilitation, or euthanasia.

Cetaceans caught in active gear, or those trailing potentially disabling gear or debris, are another matter. These rescues are generally difficult and dangerous for both the whale and people and should be undertaken only by experienced personnel and only after determining that the entanglement is life threatening. **In the U.S., attempting to disentangle a free-swimming whale without a special permit is illegal.** Permits are issued by the National Marine Fisheries Service (NMFS) on a case-by-case basis; these require an approved plan that includes safety measures for the rescuers and the animal, as well as details on animal assessment and post-rescue care.

All materials recovered from entangled animals should be labeled with the animal's field number and any other relevant data. In the U.S., these items should be sent to NMFS with the stranding report and a chain of custody form (*see* Box 10.3). Over time, these records can reveal important information on types and sources of synthetic debris and on patterns of animal interaction with coastal or pelagic fisheries.

13.1.2. Pinnipeds

The equipment and methods described in section **5.5** are useful for capturing and handling entangled pinnipeds. Once the animal is secured, rescuers must decide between immediate release (i.e., the animal is likely to survive and poses no risk to the wild population), rehabilitation, or euthanasia. If the entanglement appears to be recent and has caused no appreciable injury, remove the material, mark or tag the animal, and release it on-site or at a more suitable location. When material is embedded deeply in the flesh, as often occurs around the neck and head, removing it may cause severe bleeding. If the option exists, take the animal to a care facility. If not, consider euthanasia as a humane alternative (*see* **4.6**).

<u>Disentangling Pinnipeds</u>

Before attempting to remove entangling material, restrain the animal by either physical or chemical means (*see* **5.5**). Blunt-tipped hooks on the ends of short poles (ax handles work well) can be used to reach through a capture net to snag the debris, which can then be pulled slightly away from the animal and cut, using a blunt-tipped knife on the end of a pole. If the animal is anesthetized or tightly restrained, hemostats or needle-nosed pliers can be used to seize the material, and a knife or scalpel to cut it. In either case, pull the material away from the animal slowly, making additional cuts as needed. When removing netting, piece it together and try to account for all the material. With deeply embedded debris, this can be difficult and may require careful probing of the wound.

Once the debris has been removed, debride the wound and shave the hair on either side. This allows for easy cleaning of the area, prevents hair from irritating the wound, and reduces the chance of infection.

Remove fishhooks with care[4]: pulling out a barbed hook can damage tissue. For barbless and superficially embedded hooks, apply downward pressure to the shank and then back the hook out of the skin along the path of entry. For more deeply embedded hooks, tie strong line to the bend in the shank (or grip it with pliers), depress the shank against the skin, and firmly pull on the line. For a hook with the tip embedded but close to the skin, the best approach may be to advance the hook out through the flesh, snip the barb off with side cutters, then back the shank out. Sometimes gripping the hook with a pair of pliers and straightening it allows easier removal with minimal tissue damage.

Animals with fishing line in the mouth and throat but no visible hook should be radiographed to determine whether a hook is present. It is sometimes possible to remove a small hook from deep within the throat without surgery. With the animal anesthetized, slip a piece of stiff, heavy plastic tubing over the fishing line, and gently slide the tubing down the animal's throat until it reaches the hook. Pull the

line taut against the exposed end of the tube, then push tube and line inward. This often dislodges the hook, which can then be carefully pulled out through the plastic tube. Large hooks require a surgical approach.

13.1.3. Cetaceans

Disentangling a free-swimming cetacean may require pursuit and a carefully planned capture using hoop nets or other equipment[1]. These activities are beyond the scope of this book and the expertise of most stranding networks. In other cases, the animal may be obviously disabled and more easily approached. Much of the equipment required for disentanglement (*see* Box 13.1) is available at ship chandleries. All of these items can be carried by hand and transported in a pickup truck. In areas where entanglements are frequent, keep equipment in labeled boxes, ready for instant use.

Small cetaceans can be handled from small craft (4 to 8 m). Inflatable boats offer a soft landing for personnel thrown off balance. Open boats, with at least one rail-free section, reduce the risk of snagging lines. For safety reasons, conduct water rescues only during daylight hours. Rather than begin an attempt late in the day, monitor the animal overnight or relocate it early the next day. If using aircraft for surveys, make sure to comply with federal safety guidelines.

In U.S. waters, disentanglement of large whales is undertaken only by a network of trained specialists acting under a special permit from NMFS.

<u>Water Rescues</u>

Approach an entangled cetacean from behind and to one side, with the boat closing in slowly to avoid a startle response. Watch for the whale's reaction and be prepared to change the plan. Once parallel to the forebody (i.e., anterior to the dorsal fin), and at least half a body's length off to the side, assess the animal's condition and determine the appropriate action. **Stay well clear of the tail.** From a distance, use conventional binoculars with up to 7 x 50 magnification (greater magnification requires image-stabilizing binoculars.) Avoid nets or lines that could foul the boat's propeller: such material may trail far behind the animal. Once the plan has been determined, brief the team. **Emphasize safety. Make sure each team member knows exactly what to do.** Some teams prefer using hand signals to maintain communication, others recommend helmets with cameras and radios[2]. Once close, keep noise and commotion to a minimum.

The greatest hazards to the team can involve equipment (e.g., net frames and poles) wrenched aside by a struggling whale, lines caught on the boat or around personnel, or buoys flying off-deck under tension or swatted by an animal's flukes. **Wear a wetsuit, a flotation vest, and a safety helmet.** Polarized sunglasses reduce glare and enhance visibility into the water.

Box 13.1. Specific Equipment

Universal poles: These aluminum or wooden poles are designed to deploy mooring snap hooks, grapnels, net hooks, and net knives (*below*). Painting the poles bright orange makes them visible. Cap the ends of aluminum poles so they will float. Poles can be made in 2.5-m sections for easy storage and shipping; sections can be bolted together for a longer reach.

Mooring snap hooks: The snap hook's spring-loaded jaw is slipped into a stainless steel track fastened to the end of a pole, so that the hook is open. When the hook is snagged, it slides off the metal track and snaps shut. A line can be fastened to the snap. These devices are normally used to attach a line onto a mooring buoy with a pole but work well for snapping onto entangling material.

Grapnels: These small anchors with four or five hooked tines can be thrown into a mass of netting around an animal. Special releasable grapnels with only two tines can be deployed with a universal pole, allowing more precise placement. The two-tined style is less likely to snag lines used in the rescue.

Ground line: A ground line (3- to 4-cm diameter and up to 200 m long) is used to attach buoys and a sea anchor to the entangled animal. The large diameter allows handling without chafing. Heavy polypropylene line floats and is less likely to be severed by boat propellers during rescue. Splice "eyes" at intervals along the line for snapping on buoys.

Buoys: Brightly colored, inflatable buoys are useful for marking the ground line or the entangling material; these can be deflated for compact storage. A few buoys about half a meter in diameter are adequate for small odontocetes. At least six 1-m buoys will be needed for large cetaceans. A short line spliced to each buoy, culminating in a snap hook, makes for rapid, easy attachment.

Marker buoys: A marker buoy secured near the end of the ground line will help rescuers monitor the entangled animal. The buoy, a counterweighted pole on a float, is designed to stay upright even when pulled through the water; a brightly colored flag will make it visible from a distance. The marker buoy can also be fitted with a radar reflector and a waterproof strobe light, or with radio or satellite transmitters to allow remote tracking.

(*continued*)

With slow-moving or immobile animals, a rescuer wearing a dive mask and secured firmly by rope can hang over the side of the boat to examine the situation from a safe distance. A careful assessment (*see* **6.6.1**) is fundamental to developing an effective rescue plan—bearing in mind that methods used in one case may not work in another.

Catching or Slowing Entangled Cetaceans

Cetaceans entangled in nets pose a significant hazard for rescuers and rescue boats alike. Porpoises, dolphins, and other small cetaceans often can be captured, brought aboard and quickly disentangled, or even disentangled without removing them from the water. However, even small animals must be handled with care. Disentangling a large whale, no matter how docile it may appear, demands extreme caution and perhaps days of effort.

<u>Box 13.1. Specific Equipment</u> (*continued*)

Sea anchors: Sea anchors act like upside-down underwater parachutes. When secured to the end of the ground line, they can slow or stop a whale, or create enough drag to allow rescuers to cut through entangling material. A short buoy line attached to the center of the sea anchor will cause it to collapse when pulled, allowing easy retrieval.

Net hooks: Blunt-tipped hooks on the ends of poles can be used to pull entangling material off animals, clear lines, etc.

Net knives: Several types of net knives can be purchased or fabricated. Serrated, stainless steel knives work well for cutting entangling material by hand. Knives with a 25- to 30-cm-long blade that is rounded on the end are useful (available in restaurant supply stores); the rounded ends prevent rescuers or animals from accidental stabbing by the knife tip. Knives can be fitted on the end of universal poles but should be removable for easy sharpening. **Safety knives (i.e., retractable blade) are recommended for close work with lines or nets.**

Take a good supply of sharp knives. Sharpening dull knives during the rescue or trying to make do with dull blades wastes valuable time. For safety, cover all cutting edges for storage.

Disentangling methods vary among rescuers and their experiences with particular species. One approach is to begin cutting away at the net until the animal is free. This works well with anchored nets. With free-swimming whales, however, such action results in progressively less control over the animal as the drag from the net is eased, and the animal may escape still carrying some netting.

One method used on the U.S. West Coast is to first attach a ground line, buoys, marker, and sea anchor. These will mark the animal if it submerges or the rescue is called off, allow easy recovery of the debris after it is cut free, and prevent the animal from sounding and slow its movements. The ground line can be attached by slipping a mooring snap hook or grapnel into the thickest part of the netting (ideally around a float or lead line) or around as much netting as possible. When the hook or grapnel is released, the attached heavy nylon line, which is taped to the universal pole, breaks loose; this line is attached in turn to the ground line. Rescuers attach buoys to the ground line as it runs out and, once the line is out, attach additional buoys along the length of the line and deploy the sea anchor at the end. Once the whale has slowed, attaching additional buoys directly to the netting, as close to the whale as possible, will mark the animal, prevent it from sounding, and help with material recovery. A second ground line may be attached for added security. **Consider in your planning that this approach may not work on some species, including right whales[2], and that prolonged physical incapacitation of a strong animal can cause additional stress and injury, e.g., capture myopathy.**

If night closes in before the whale has been freed, or the sea becomes unfriendly, back off the approach, track the whale from a distance, and wait until conditions are safe to resume.

Releasing Entangled Cetaceans

Before cutting a whale loose, determine how the animal is entangled. Trap lines, mooring lines, or other single-line entanglements often can be cut loose using a knife on the end of a pole. If floating line or buoys are attached, and the entangling material is wrapped only once around the animal, cut the section without floats as close as possible to the whale. Keep well away from the flukes. Once the non-buoyant section is cut, the rest often can be pulled free by placing tension on the buoy or floating segment.

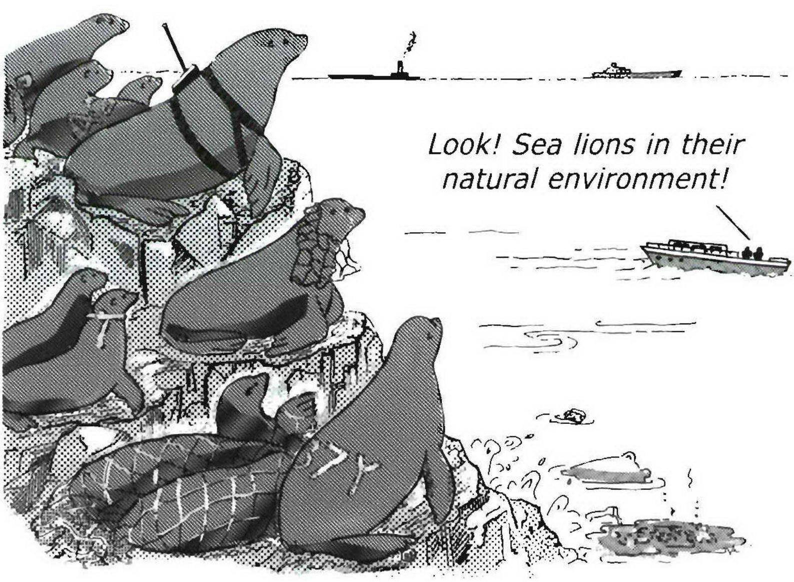
If no part of the entangling line floats, attaching a buoy prior to cutting will make the material easier to retrieve. The buoy can be snapped on in front of any loop, knot, or other bulge in the line; alternatively, it may be necessary to make a knot. In either case, speed, skill, and timing are essential. The line must be snagged, then the boat speeded up slightly to provide enough slack to clip on the buoy; the farther back on the line it is attached, the better for marking the whale's location if it dives. The entangling line can be cut when the animal surfaces. When the line cannot be cut entirely, one option is to cut it as close to the whale as possible to reduce drag. Whether to employ this or other options depends on the type and amount of line and gear, and the type and condition of the animal, and is best left to the judgment of an experienced rescue team.

Rescuing net-entangled cetaceans is generally more complicated. In many cases, most of the netting can be cut free while leaving in place key segments that hamper the animal's movements. Once strain is reduced, a whale often becomes more active in freeing itself from the remaining material. Plan cuts carefully, taking advantage of the whale's strength. Take care not to cut away the material to which the ground line is attached until the last moment, and attach additional buoys if some are cut free. With active fishing gear, ideally work with the fishermen who own the nets to minimize damage and maintain good relationships and support.

When the flukes are entangled, it may be best to cut away most of the material on top of the flukes first, since it is easier to see and to reach, making sure that the netting under the flukes is still attached to the ground line and buoys. The faster the material is removed, the less the risk of entanglement or injury for rescuers. Once the material on top is removed, the rest often slides off due to drag.

Precautions

- Animals often struggle violently when gear is loosened or shifted. Consider the animal's potential movements and be prepared to move quickly out of harm's way.
- Some experienced rescuers enter the water to assess the type and extent of entanglement and to disentangle the whales. This practice is dangerous (at least one person has been killed) and in some areas is prohibited[3]. **Disentanglement of cetaceans should be carried out from a boat.**
- Monitor or track disentangled animals for several days to make sure they have recovered from the event. Document the team's actions, ideally by video, for review and evaluation.



13.2. TAGGING AND MONITORING

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13.2.1. General Considerations

The primary purpose of returning a beached marine mammal to the sea is to allow it to live and flourish after what is usually a life-threatening event. But how do we know if a released animal does subsequently live a normal life? How can we tell if the time and money invested in its recovery and rehabilitation, let alone the stress and trauma it suffers during the process, is justified by the outcome? The answer is by monitoring the animal after release, and that invariably means by applying some sort of tag or mark.

The subject of marine mammal tagging is diverse, complex, and rapidly evolving[5,7]. The objective here is a brief, practical guide to what tagging involves, its strengths and weaknesses, and the many issues that should be considered when determining the type of tag to use, if any. Tagging generally requires planning and special equipment and should only be carried out by people skilled in the technique to be used. Nothing will be gained, and much can be lost, by applying inappropriate tags—or appropriate tags incorrectly.

First, consider the type of information desired and, second, the costs and benefits of the selected method. A cost-benefit analysis is an important step to justify the use of funds and other resources as well as the potential impacts on animal welfare.

Tagging can answer a number of questions about a stranding event:

- How many animals are involved in a cetacean mass stranding when dispersed animals come ashore and are refloated independently?
- Are refloated cetaceans restranding further along the coast?
- Do refloated cetaceans move offshore and out of danger of restranding?
- Do animals released in a group remain together?
- Do animals that strand outside their normal range and are returned to that range remain there? Do those released at the beaching site return to their normal range?
- Do rehabilitated animals resume normal diving behavior after release?
- Do stranded seal pups survive after prolonged rehabilitation and eventually join the breeding population?

13.2.2. Techniques

Each of the many tagging techniques has its advantages and disadvantages (*see* Tables 13.1 and 13.2). In general, both costs and benefits increase from top to bottom. A program with few resources will have no opportunity to adopt the more expensive techniques and will then need to decide whether the information gained

from the more economical methods are (a) desirable and (b) merit the costs. A wealthier project may be able to afford an expensive tagging program but still must carefully weigh the benefits against the costs. In principal, the simplest option that gives the desired information should be adopted.

A great variety of tags and marks have been applied to marine mammals in the past few decades; the relatively few described below have proven successful and are the most suitable for post-release monitoring of stranded animals.

Table 13.1. Tagging techniques for pinnipeds

Technique	What's Involved	Advantages	Disadvantages	Information Gained
Plastic 'cattle' tag	Paired tags attached to the flipper webbing with a single plastic pin.	Trivial cost, quick procedure (<1 min), very little physical trauma, no follow-up costs. Can be stored indefinitely awaiting use.	Only useful if the animal is seen again at close quarters (comes ashore again).	*That an animal subsequently seen is or is not the one you released.
Head tag	High-visibility numbered tag is glued to the top of the head.	Low cost. Visible at distances of up to 100m through telescope or binoculars. Can be stored indefinitely awaiting use.	Only useful if the animal is seen again.	*That an animal subsequently seen is or is not the one you released.
Hot branding	Mark applied to skin with a very hot metal brand.	Small cost, potential long life.	Only useful if the animal is seen again at close quarters. Healing process prolonged; can cause infection.	That an animal subsequently seen is or is not the one you released. Possible long-term re-sighting data.
VHF radio tag	Electronic package glued to the fur of the head or shoulders.	Ability to detect the animal at ranges of a few km from land or ship, 10s of km from aircraft. Low tag cost compared to satellite tag.	Costs will be high if ship or aircraft needed for tracking. Information only when you are in range.	Movements, ability to relocate the animal if it doesn't go beyond your tracking range. Proof of survival.
UHF satellite-linked radio tag	Electronic package glued to the fur of the head or shoulders.	Ability to track animal anywhere in the world without the need to follow it by ship or aircraft.	High cost per animal for tag. Daily charge thereafter.	Movements, ability to relocate the animal. Diving behavior; proof of survival.

*Even basic tags can provide a variety of other data (e.g., tag retention time, successful reproduction as demonstrated by the presence of a pup, or large-scale movements), provided the animals are resighted (or restrand) before the tag is lost.

Table 13.2. Tagging techniques for cetaceans

Technique	What's Involved	Advantages	Disadvantages	Information Gained
Plastic 'cattle' tag (small cetaceans only)	Paired tags attached to the dorsal fin with a single plastic pin.	Trivial cost, quick procedure (<5 min), very little physical trauma, no follow-up costs.	Only useful if the animal is seen again at close quarters (e.g. if it restrands). Likely short life (weeks/months).	*That an animal subsequently stranded is or is not the one you released.
Freeze-branding (small cetaceans only)	Mark applied to skin with a very cold metal brand.	Small cost, no trans-dermal trauma, potential long life.	Only useful if the animal is seen again at close quarters (e.g., if it restrands).	That an animal subsequently stranded is or is not the one you released. Possible long-term re-sighting data.
VHF radio tag	Electronic package attached to dorsal fin with pins, a blubber anchor, or a suction cup.	Ability to detect the animal at ranges of a few km from land or ship, 10s of km from aircraft. Low tag cost compared to satellite tag.	Costs high if ship or aircraft needed for tracking. Information only when you are in range. Relatively high physical trauma for longer-term results. Very short-term (hours) if suction cup used.	Movements, ability to relocate the animal if it doesn't go beyond your tracking range. Proof of survival (not suction cup).
UHF satellite-linked radio tag	Electronic package attached to dorsal fin with pins or via a blubber anchor.	Ability to track animal anywhere in the world without the need to follow by ship or aircraft.	High cost per animal for tag. Daily charge thereafter. Relatively high physical trauma.	Movements, ability to relocate the animal. Diving behavior; proof of survival.

*Even basic tags can provide a variety of other data (e.g., tag retention time, successful reproduction as demonstrated by the presence of a calf, or large-scale movements), provided the animals are resighted (or restrand) before the tag is lost.

The costs of a tagging project are measured in more than money. There is usually some cost to the animal—perhaps short-term pain and/or longer-term discomfort, or an energetic cost of bearing a tag—and to the project in terms of human and other resources needed to carry out the work. There is no point in spending thousands of dollars on VHF radio tags, for example, and subjecting the animals to the trauma of attaching them, if there is no provision for time and money to track the tagged animals after release.

Tagging techniques for large cetaceans are fewer, and more specialized, than for porpoises, dolphins, and smaller whales. Very few beach-cast large whales are refloated alive, but those entangled in fishing gear may be freed successfully. Tagging these whales with remotely-deployed VHF- or satellite-transmitters may well yield important information about their subsequent survival and movements, but such studies should only be attempted by the few teams around the world who specialize in this work.

Box 13.2. Tag Types and Attachment Techniques

Freeze brands: Brands can be cooled in either an alcohol/dry ice mixture or in liquid nitrogen. The duration of brand/skin contact depends on several factors, but is normally in the range of 10-30 seconds. Relevant factors include the temperature of the brand (nitrogen is much colder than dry ice), the mass of the brand (a larger mass will require less contact time), and the type of skin. The soft skin of young animals, for example, requires less contact time than does the harder, deeper epidermis of an older animal.

Hot brands: Used only on pinnipeds. This technique has the advantage that hair need not be removed from the branding site, but the disadvantage of possible infection from the burn wound. Contact time depends on brand temperature and skin/hair type. A hot brand results in a permanently bald mark, so lasts for the lifetime of the animal.

Pin attachments: Often used to hold a radio tag to the dorsal fin or ridge of a cetacean. Use nylon or delrin with a diameter of 6-8 mm, threaded at the ends (at least). Cap with nuts and perhaps washers. The use of nylon allows the nut to be sealed in place with heat. The advantage of using a nut is that the final length of the pin can be tailored to what's required. Clean the skin around the attachment site and apply a sub-dermal local anesthetic. Bore a hole of a slightly smaller diameter than the pin through the fin with a sharp cork-borer, using a twisting motion. This causes less tissue damage than forcing a pointed pin through (e.g., as with a cattle ear-tag). Immediately apply the tag. Any hemorrhaging will be diminished or stopped by the clean pin.

Gluing: Not used for cetaceans because there is no suitable substrate, but normally the technique of choice for pinnipeds with hair (all but the walrus). Thoroughly clean the attachment site with alcohol to remove dirt and grease; rub 2-part, quick-setting epoxy glue into the fur, avoiding touching the skin where possible; and apply the tag directly to the glue. Attaching the tag first to a piece of loose-weave fabric or similar material provides greater surface area for the glue to adhere.

Suction cups: For cetaceans with a smooth skin, short-term attachments (hours to a few days) of an electronic device can be obtained by using either one large suction cup or many smaller ones.

Hose clamps (jubilee clips): Only two marine mammals (walrus and narwhal) offer a hard, external substrate to which a tag can be attached. The tusks of both species are sufficiently large and robust to take a rugged electronic package. Satellite transmitters are the tag of choice because they allow the animal to be followed anywhere in their remote arctic range.

Plastic tags: Designed to be anchored to the animal and come in many different shapes and sizes. Most types tried over the years have been abandoned; simple cattle ear tags of various shapes and sizes continue to be popular because they are quick to use and usually last for months or years. These can be applied directly to the inter-digital webbing of a pinniped flipper or the trailing edge of a small cetacean's dorsal fin.

Head tags: Designed specifically for gluing to the head of seals by the Sea Mammal Research Unit (St. Andrews, UK), the head tag (Dalton, UK) is made of rugged lightweight plastic and has large embossed characters on 3 sides for easy identification at a distance.

(*continued*)

Box 13.2. Tag Types and Attachment Techniques (*continued*)

VHF tags: (Often referred to as "radio tags," although the term is equally applicable to satellite tags.) These devices emit a pulsed radio signal, usually in the 150-172 MHz range, which can be sensed by either hand-held or automatic receivers and used to determine the location of the animal carrying the tag. The tags comprise a circuit board and battery inside a pressure- and water-proof housing (normally mold epoxy or urethane) and an external antenna.

Satellite tags: Sat tags are similar to VHF tags, except that they emit a radio signal at a higher frequency (usually 401.5 MHz in the UHF range for Service Argos) and that the signal is designed to be picked up by polar-orbit satellites rather than by receivers on land, boats, or aircraft. Sat tags normally provide a location at least once a day and can transmit data on animal behavior, environmental conditions, or both. Information sent to the satellites is usually forwarded to the service provider (Service Argos in France or Maryland) and subsequently provided to the user along with a timed estimate of the location of the animal when the tag was sensed by a passing satellite.

Ethical Considerations

Contact with marine mammals is often controversial, and marking or tagging them is especially so. Some people object to tagging on ethical grounds regardless of the justification, while others will consider almost any technique. There is no universally right or wrong stance on this issue, but certainly a broad spectrum of views. Attention has recently been particularly focused on the justification of using so-called "invasive" tag attachments, usually interpreted as those that involve piercing the skin. I would simply make the observation that some ostensibly 'non-invasive' attachments such as a harness or suction cup can cause more apparent distress to a cetacean than a pin inserted through the dorsal fin. The same principle applies in pinnipeds. Here, gluing a tag to the fur is a standard technique and sounds (and usually is) innocuous. But in a small minority of cases such attachments can cause behavioral or physical problems, and should not be automatically preferred to a plastic tag pinned through the webbing of a hind flipper. The moral is to discard preconceptions, weigh the costs and benefits, and consult someone with lots of experience with both the species and applicable techniques.

Costs to the Animal

How does one measure cost to the animal? This is a difficult question to answer, especially in terms of pain and stress, but there are some obvious guides to the more tangible costs. First, what is the chance that the animal will die during, or as a result of, the procedure? For example, larger, more aggressive pinniped bulls of some species (e.g., sea lions, gray seals, or elephant seals) may need to be tranquilized or anesthetized before they can be handled, which carries its own risks. While risks are slight for healthy animals, a dolphin or seal weakened by stranding could be further compromised by any traumatic tag attachment. Consult an experienced veterinarian.

Second, what are the post-release risks? These include tissue reaction to the tag and a greater probability of entanglement in nets and debris. The latter risk is generally negligible but could be a factor, for example, in a coastal species that habitually takes fish from nets. Tissue reactions vary from individual to individual, species to species, and technique to technique. Resulting infections are generally rare, but are more frequent in animals that spend time on land in unhygienic conditions than those remaining at sea. Some radio tags (usually involving a 'wrap-around' design) can cause enlarged wounds on the dorsal fin of dolphins if the device is not released properly. For this reason, attachment design must include a mechanism for the package to be shed when it is no longer required. This can be achieved through corrosion of a sacrificial metal nut, for example, or by fatigue of a restraining cord or a fabric washer. In all cases the objective is for the radio tag to fall away without harming the animal, and for the attachment site to heal quickly. In seals, flipper tags can cause short-term infections, but these usually heal well when the animal goes to sea. Tags glued to the fur are normally released at the next molt, after periods of months.

Box 13.3. Sources of Tags and Tagging Equipment

Plastic tags/seal head tags

- **Dalton ID Systems Ltd.**, Dalton House, Nettlebed, Henley-on-Thames, Oxon RG9 5AA, England. Tel: 44 1491 642500; Fax: 44 1491 642501; www.dalton.co.uk.

VHF/satellite tags

- **Advanced Telemetry Systems, Inc.**, 470 First Avenue North, P.O. Box 398, Isanti, MN 55040, USA. Tel: 763-444-9267; Fax: 763-444-9384; www.atstrack.com.
- **Holohil Systems Inc.**, 112 John Cavanaugh Drive, Carp, Ontario, Canada K0A 1L0. Tel: 613-839-0676; Fax: 613-839-0675; info@holohil.com; www.holohil.com.
- **Lotek Wireless Inc.**, 115 Pony Drive, Newmarket, Ontario, Canada L3Y 7B5. Tel: 905-836-6680; Fax: 905-836-6455; www.lotek.com.
- **Sirtrack Ltd.**, Private Bag 1403, Goddard Lane, Havelock North, New Zealand. Tel: 64 6 877 7736; Fax: 64 6 877 5422; sirtrack.landcareresearch.co.nz/index.asp.
- **Telonics Inc.**, 932 E. Impala Ave., Mesa, AZ, 85204-6699, USA. Tel: 480-892-4444; Fax: 480-892-9139; www.telonics.com.
- **Wildlife Computers**, 16150 NE 85th Street, Suite 226, Redmond, WA 98052, USA. Tel: 425-881-3048; www.wildlifecomputers.com.

13.2.3. Follow-up

Although thousands of stranded marine mammals have been refloated or released after rehabilitation, remarkably little is known about their subsequent fate. As the marking of rehabbed oiled seabirds has shown, much can be learned from the process of marking such creatures and collating subsequent sightings and other data (such as radio tracking). Indeed, it is arguably unethical to release an animal that might otherwise have died quite quickly of natural causes unless we know that in so doing we are not likely causing it to endure a more prolonged and stressful demise. Rescuers of stranded marine mammals should be encouraged to fill this information gap where they can, knowing that their efforts will result in better decision-making on beaches, and improved care of such unfortunate animals around the world.

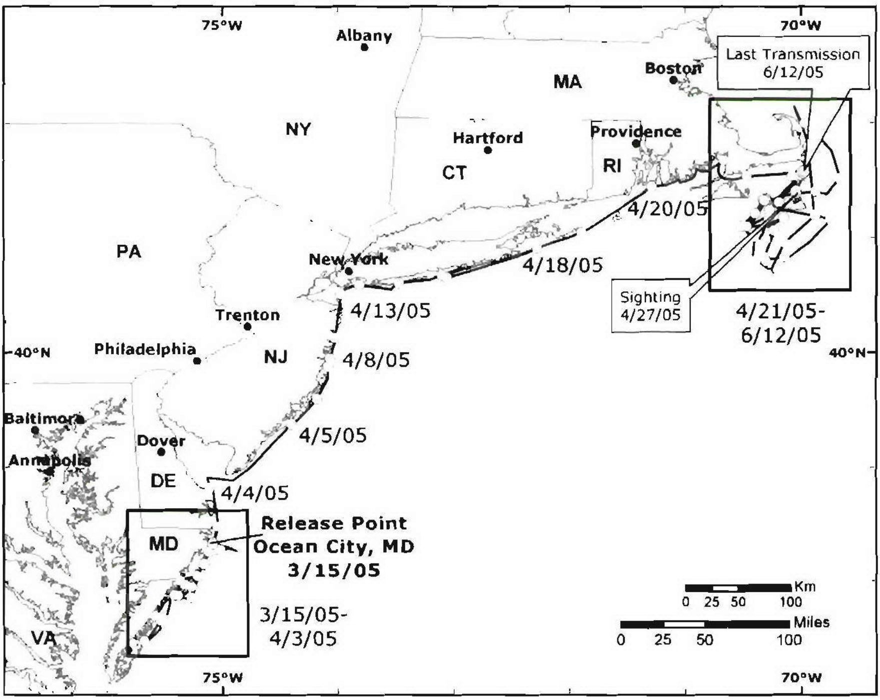


Fig. 13.1. A juvenile harbor seal rehabilitated by the National Aquarium in Baltimore and released at Ocean City, MD, was tracked for three months by satellite. The track reveals several important points about the animal's release. After the first two weeks, the seal moved in a more or less straight line without backtracking or getting lost, traveling close to shore along a busy coastline at an average rate of more than 40 km/day, to a place where it likely foraged for at least 50 days—good evidence that rehabilitation was successful.

13.3. GIS APPLICATIONS

Gregory Early, A.I.S., Inc., New Bedford, MA

13.3.1. General Considerations

Does a rehabilitated marine mammal's story end when it returns to the ocean? From the animal's standpoint this was, hopefully, a brief period of rest, free food, and some minor discomfort. The rest of life awaits, i.e., "So long, and thanks for the fish." From the rehabilitator's standpoint, however, questions remain. How well do we understand the results and the repercussions of all of the hard work and effort? How appropriate, on an individual or a population scale, was our care? Can our care be improved, and does our responsibility end when an animal disappears from view?

Until recently, these questions were difficult, if not impossible, to answer. The tools to evaluate success did not exist, and experience gathered during rehabilitation and "best guess" conjecture generally had to suffice. Coincidental advances in three fields of technology, however, now offer the means to answer these questions and perhaps change our fundamental notions of stranding and rehabilitation programs.

Individually, each piece of technology—the Internet, telemetry, and geographic information systems (GIS)—is a powerful tool for collecting, manipulating, and distributing information. Together, they can be uniquely suited to address problematic questions on the dynamic environmental and biological factors surrounding strandings, the effectiveness of rehabilitation programs, and the links, if any, between stranding programs and the conservation and management of the wild populations that those programs serve.

13.3.2. Internet

The Internet has benefited stranding programs in three major ways. First, the Internet is, if anything, a way to exchange large amounts of information. It is almost by definition a data-swapping network. Stranding organizations are structured primarily as networks bound more by common objectives and geography. The Internet allows these organizations to share years' worth of knowledge with the press of a key.

Second, better data exchange leads to better animal care and use. The sharing of information among rehabilitation centers both maximizes resources and avoids duplication of effort. Many rehabilitators are familiar with the words "well, at least we'll learn something"—a feeling often expressed while carrying out an uncertain decision. By broadening the "we" to the largest group, more people learn from such efforts, and fewer animals are subject to adverse, but well-intentioned, trials.

A third value of the Internet may prove to be the most powerful. That is the ability to move and share large amounts of data. Huge sets of information, including geographic, tracking, environmental, and human and animal population demographic data, are no longer confined to libraries or research centers.

13.3.3. Telemetry

Telemetry is the science of gathering and transmitting data from remote locations. Tracking methods, procedures, and equipment (*see* **13.2**) are powerful applications of telemetry technology. Telemetry data can include everything from biosensor data to global sea surface temperatures gathered by satellite, to images from remote cameras. Combining data sets with remote sensing and tracking capabilities makes it possible to visualize information on scales ranging from near microscopic (the movement of a penguin's beak) to global (ocean ice data). Combined with high-speed Internet capabilities, global data sets are literally at one's fingertips.

In the past, tracking technology was prohibitively expensive, the tags large and cumbersome, and their reliability marginal. The demand for miniaturized electronic gadgets, from PDAs to portable music players, has driven down the size and cost of telemetry devices. Reliable and well-tested technology is now readily available and constantly improving, making this technology increasingly accessible and appropriate.

13.3.4. GIS

Geographic information systems are, simply put, a way to work with data spatially. GIS is a tool for visually displaying and analyzing data on spatial trends and patterns. Several types of GIS software are now available for desktop computers, bringing new power to understanding temporal and spatial relationships surrounding stranding and mortality events: weather, currents, oil spills, toxic algal blooms, fishing effort, and boating traffic (to name a few). At its simplest level each stranding is a case file, a single story or data point. GIS groups them together with other information that can transform what would otherwise be spreadsheets and bar graphs into the actual multi-dimensional, geographic world in which the events are happening. These data can be manipulated to explore patterns, define relationships, and evaluate trends. For example, a set of location points—say for a tracked animal—can be placed across the surface of the ocean to demonstrate a movement pattern. Data on weather, hydrography, depth, biological productivity, associated fauna, harmful organisms, ship traffic, discharges, etc., can be added to round out the picture. This kind of information is needed to develop life history models and, from there, strategies for better managing populations and protecting their habitats.

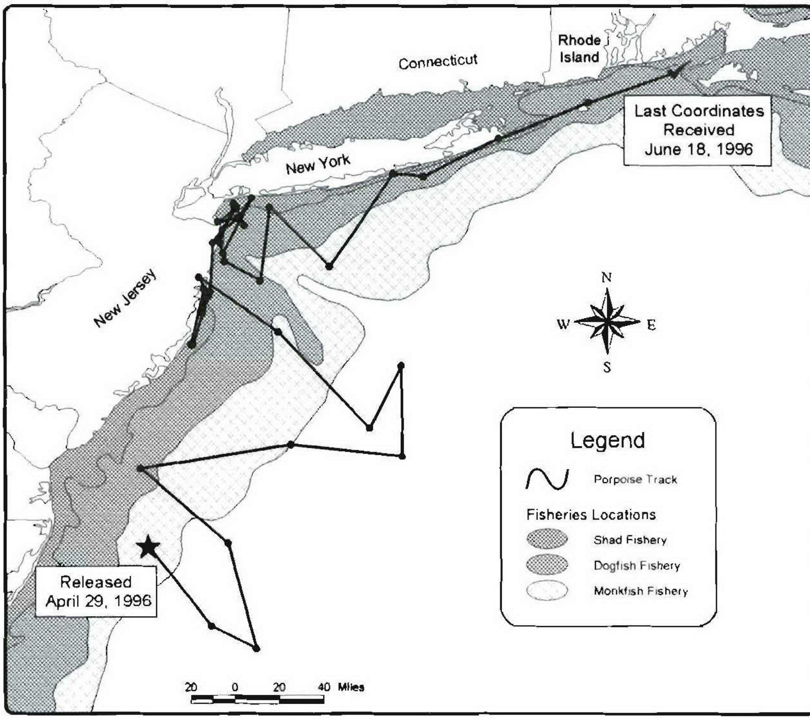


Fig. 13.2. The 6-week track of a harbor porpoise rehabilitated and released by the National Aquarium in Baltimore demonstrates this species' exposure to gillnet fisheries along the U.S. Atlantic coast[6]. Data indicating other threats, including shipping traffic and hazardous material spills, may also be linked to tracking data through GIS applications.

Table 13.3. Internet Resources for GIS

Name	Web address	Further information
General/Education		
Biotelemetry Directory	www.tamug.edu/labb/Links.htm	Links to a range of additional biotelemetry information and resources.
GIS Lounge	www.gislounge.com	Links to additional GIS resources.
International Society on Biotelemetry	www.biotelemetry.org	Use of telemetry in medicine and life sciences.
Society for Conservation GIS	www.scgis.org	Use of GIS for conservation of natural resources and cultural heritage.
WhaleNet	whale.wheelock.edu	Tracking data and maps for released animals along the U.S. Atlantic coast.
Software		
Autodesk	www.autodesk.com	Makers of MapGuide and AutoCad products.
DIVA-GIS	www.diva-gis.org	A free GIS program, designed for measuring species distribution.
ESRI	www.esri.com	Makers of the Arc-line of GIS products, including ArcInfo, ArcView, and ArcExplorer.
MapInfo	www.mapinfo.com	Maker of MapInfo and MapXtreme products.
RockWare	www.rockware.com	Provider of a variety of GIS products and services.
Data		
National Geospatial Data Clearinghouse	clearinghouse1.fgdc.gov	Searchable collection of data servers run by the US Federal Geographic Data Committee.
Geography Network	www.geographynetwork.com	Many data sources that can be directly linked into ESRI products.
National Geophysical Data Center	www.ngdc.noaa.gov	Source for NOAA data through the Satellite and Information Service.
Ocean Biogeographic Information System	www.iobis.org	Data from the Census of Marine Life.
Remote Sensing and GIS Resources	cbc.rs-gis.amnh.org/	Introduction to/resources for remote sensing data.

Chapter 14
The Follow-up

The file on a stranding event is never closed until all information has been archived for easy retrieval, tissues are safely stored for later analyses, equipment has been cleaned and returned, team members are recognized for their efforts and informed of the outcome, and the community is thanked for its support.

14.1. COLLECTION AND DISTRIBUTION OF DATA

The story of an event is best written while memories are fresh and documents readily accessible. Once everyone has returned to their other obligations, first-hand information is lost, and what the account gains in the re-telling, it loses in accuracy.

Ideally while still on-site, or soon after returning to the lab or Operations Center, the team leader will hold an informal "debriefing" to elicit individual points of view, experiences, criticisms, and suggestions, which will be included in the event report. A mass stranding or unusual mortality event may include additional meetings soon after the event to solicit comments from volunteers, town officials, cooperating agencies or businesses, and interested members of the public. The team member assigned to prepare the report needs the skills to filter through the volume of information, recognize what is important, and condense it into useful form.

Event coordinators should resist the temptation to postpone the report until "all" information is complete or every sentence perfect. The immediate need is for a summary of essential findings from each of the coordinators—including reports from the debriefing meeting—accompanied by the kind of documentation that can later be organized, analyzed, and refined. This summary should then be made available to team members, relevant federal and state agencies, and if appropriate or requested, to other regional stranding networks. **In the U.S., a completed Level A data form (Appendix B) provides the minimum information required to officially document a stranding event.**

Points to summarize in the report include:

1. Notification of the stranding.
2. Eyewitness accounts.
3. Nature, timing, and effectiveness of the initial response.
4. Account of the scene as first viewed by the team.
    - exact location
    - pattern of stranding
    - condition of animals
    - environmental conditions
5. The action taken and reasons for the decisions.
    - intended response plan
    - impediments to implementation
    - eventual action
    - intended follow-up (monitoring released animals or following progress of rehabilitation)
6. Necropsy findings and any available laboratory results.
7. Types of data and specimens collected and their location.
8. Supplementary information.
    - maps, photographs (aerial photographs are available online), sketches
    - reports from independent groups, e.g., police, Coast Guard, wildlife authorities
9. Critique of methods and success, including safety issues; suggested improvements.

The initial report should be continually updated as new information becomes available, until it eventually emerges as a completed document. This report may be read months or years later by persons unfamiliar with the event. Content must be clear and thorough; seemingly insignificant details may prove valuable in retrospect. Enlisting one or more colleagues less familiar with the event to review the document can reveal areas that need clarification.

Most centers have the capacity to enter all relevant data into an electronic database. This should be searchable by a number of parameters (e.g., age class, sex, county/region, date of recovery, tissue type, analytical test, cooperating laboratory, and case identification number) and updated as information is obtained. Electronic files can be shared with other networks and submitted to the appropriate regulatory agencies. The use of accepted standards and formats (e.g., **Level A data at a minimum for all events**) will enhance "networking" and database development.

Original (i.e., paper) files for each animal should contain copies of all shipping documents, a copy of the original necropsy report, a copy of the updated database files, and copies of correspondence and data sheets. A separate "event file" for

mass strandings or unusual events, including data relevant to all animals involved (e.g., environmental data and sampling), will avoid unnecessary searching through individual files. **Maintain paper files in a secure location and back up electronic files regularly.** Ideally, original records should be archived and curated; if necessary, a local library or museum may be willing to provide space and expertise.

In the U.S., the federally appointed on-site coordinator is responsible for preparing the report following an unusual mortality event. In addition to details on the response and results of analyses, this report contains an assessment of the impact on affected populations (*see* **2.7.3**). Effective investigation and documentation of unusual events requires that each network or agency involved provides relevant data to the federal coordinator in a timely and consistent manner. Each network should also maintain complete records of the local team's involvement and observations, and continue to work with the federal agency to produce the final report. Ongoing communication and cooperation are essential.

Strandings of rarely observed species, unusual health findings, mass strandings, and die-offs can generate a wealth of data of interest to scientists, other stranding networks, and the public. Team or network coordinators should make every effort to ensure that valuable information reaches the appropriate audience, whether through peer-reviewed publications, presentations at conferences, the network's website, or the media (*see* **3.4**). Certain information may demand prompt reporting; examples include data relevant to marine mammal welfare (e.g., diagnosis of previously

unrecognized diseases, or improved techniques for handling or treatment) or human health and safety (e.g., zoonoses). Effective information sharing will enhance opportunities for funding and community and logistic support, build the network's reputation as a "trusted voice" for public education, and help advance the efforts of stranding networks world wide.

14.2. THE SAMPLE TRAIL

Samples from strandings may be dispersed quickly to research and analytical laboratories, museums, universities, and tissue banks. Important opportunities to gain information have been lost because specimens deteriorated due to improper preservation or handling, samples were poorly labeled or lost, or analyses were never done or their results not reported. In effect, the time, effort, and resources invested in collecting such samples were wasted. To ensure better results:

- Make sure that each case is assigned a unique number or code that can be used to identify all other associated numbers (e.g., accession numbers that different laboratories may assign to the same animal) and cases (e.g., in a mass stranding).
- Protect samples from deteriorating (i.e., repackage as necessary; top-up preservatives).
- Distinguish between samples for archiving (e.g., tissue or serum banks, or other future use) and those for immediate analysis, and package and label appropriately (include a "use by" date for time-sensitive samples).
- Ensure that each sample has at least two labels (e.g., a double-bagged frozen sample with an inner Tyvek™ tag plus labeling on the outer bag with a permanent marker) (*see* **10.14.1**).
- Establish a system for tracking specimens (some pass through a series of laboratories) and maintain up-to-date records.
- Expedite sample processing and analysis.
- Ensure that results will return into the central data bank, if necessary by contractual arrangement with the recipient.

Follow **chain-of-custody procedures** when processing and sending samples that may be required for legal action. The original chain-of-custody form (Appendix C) should be completed in full and included in the shipment in a sealed plastic bag, and a copy retained in the local network's files. When properly completed, this documentation will provide the history of the sample from the time it is collected through all transfers of custody, including courier service or other common carrier, until it is received at the analytical laboratory. The laboratory's (or agency's) internal records will then track the sample through final disposition. Include the ultimate disposition of the sample or material in the final report and retain chain-of-custody records as part of the permanent documentation.

14.3. WHO PAYS?

The stranding network is responsible for settling all financial matters arising from any action taken under its authority. Some institutions have a budget for this purpose; others may rely on donations and other sources of funding. In the U.S., the National Marine Fisheries Service (NMFS) **John H. Prescott Marine Mammal Rescue Assistance Grant Program** provides some support for tissue and sample collection, live animal recovery and treatment, and facility upgrades and operations. The **Marine Mammal Unusual Mortality Event Fund** may reimburse some costs incurred during responses to unusual mortality events (*see* **2.5.3**).

Team or event coordinators can maintain the support of loyal team members by immediately reimbursing personnel costs and expenses as pre-arranged. Contractors, laboratories, local businesses, and private individuals (e.g., veterinarians, equipment operators, and divers) should not be expected to absorb the costs of a stranding response, although many do. Coordinators should settle all accounts promptly.

14.4. A PRESS CONFERENCE

The network's media coordinator should organize a press conference soon after any stranding event that has captured public interest. Keeping the press and public informed (*see* **3.4**) will encourage cooperation and support, promote public awareness, and reduce misconceptions and speculation that inevitably follow unusual events. For all but the most endangered species, the potential value of a rescued or released animal in terms of public education far outweighs any benefit to the wild population. A post-event press conference offers a good opportunity to include messages about the network's mission and concern for animal welfare, specific risks to the species involved or other marine animals in the area, and suggestions on how the public can become involved in either marine animal rescue or regional conservation programs. Allow for interviews and make copies of the condensed stranding report available to the press.

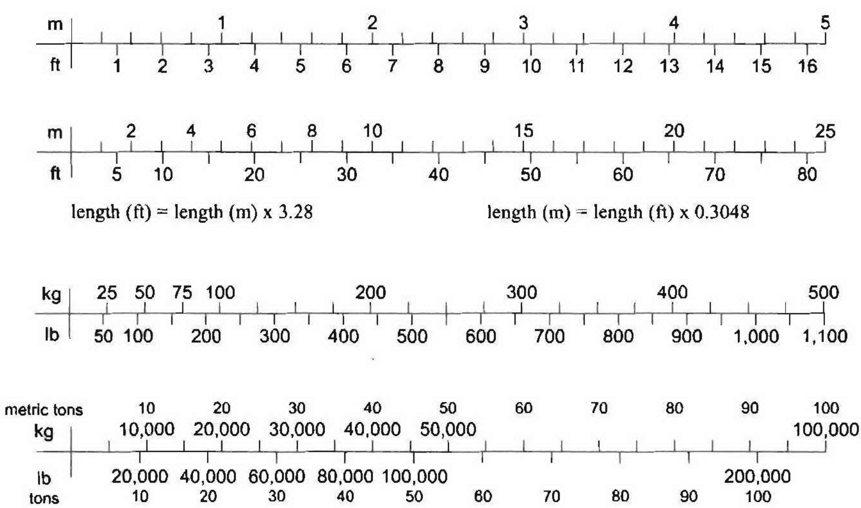
14.5. A NOTE OF APPRECIATION

Nearly everyone on the stranding response team devotes untiring effort for which the only compensation is the satisfaction of helping. Beyond that, the mayor of the town may have committed costly resources, the police worked unscheduled overtime, the community provided food and beverages, the motel keeper bore the criticism of cleaner guests, and beach residents endured the trampling of their summer gardens. Compile a list of everyone involved, including the volunteers and members of the local community (*see also* **3.5**). There is little we can do for their inconvenience that is more gratifying than providing a summary of the incident, and an expression of sincere thanks.

14.6. EVALUATION

Every stranding response generates experience or information that may be useful for improving some aspect of the network's operations. The post-event debriefing may reveal weaknesses or stimulate discussions that call for changes in routine or special procedures, team composition, logistic support, or any other elements essential for effective stranding response (*see* Chap. 2). These issues remain long after submission of the final report. Now is the time to begin to update or revise protocols, evaluate resources and organizational needs, and **start planning and training for the next event**.

Conversion Charts for Length and Weight



length (ft) = length (m) x 3.28

length (m) = length (ft) x 0.3048

weight (lbs) = weight (kg) x 2.2

weight (tons) = weight (metric tons) x 1.1

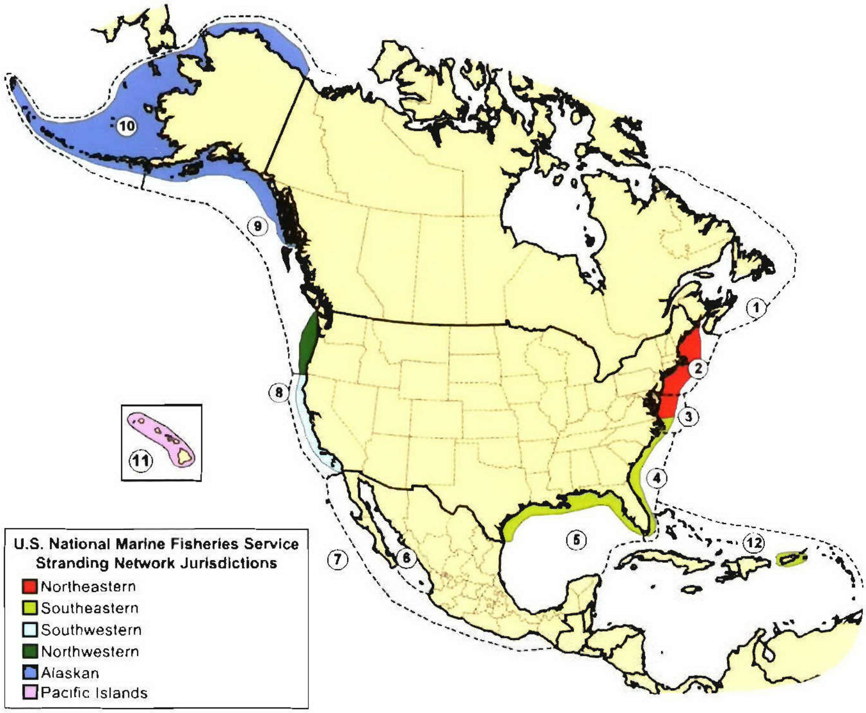
weight (kg) = weight (lbs) x 0.454

weight (metric tons) = weight (tons) x 0.907

Chapter 15

Marine Mammals of North America

A Brief Guide to Species Identification, Life History, and Stranding Frequency



Marine Mammal Zoogeographic Regions

1. Canadian Maritime Provinces
2. Gulf of Maine to Delaware Bay
3. Delaware Bay to Cape Hatteras
4. U.S. Southeastern Atlantic
5. Gulf of Mexico
6. Gulf of California
7. Western Mexico
8. California
9. Pacific Northwest to Gulf of Alaska
10. Aleutian Is.; Bering, Chukchi and Beaufort seas
11. Hawaii
12. Caribbean

Fig. 15.1. Marine mammal zoogeographic regions in Canada, the U.S., and Mexico. Area 3 is a transition zone between generally differing northern and southern fauna; strandings in this zone may be of animals from either of the adjacent regions.

Note: Descriptions and life history data in this chapter were taken from general[a] and regional[b] references, and selected reports for each species (cited in text).

a. General[62,64,65,102,103,106,122,127]

b. Regional[28,29,56,67,75,79,81,83,95,114,115,119,120,129,136,139]

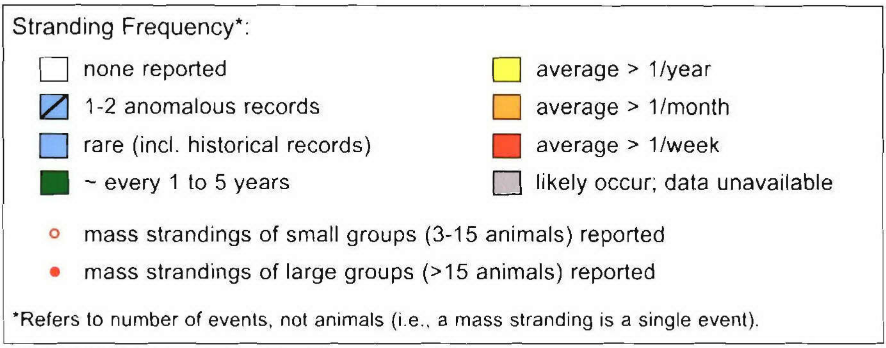


Fig. 15.2. Color key to stranding frequency.

15.1. PINNIPEDS

Order Carnivora

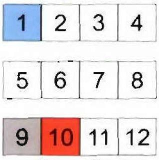
Suborder Pinnipedia

Superfamily Otaroidea

Includes the Otariidae (sea lions and fur seals) and the Odobenidae (walruses); the hind flippers can be rotated forward; females have 4 mammary teats.

Family Odobenidae (Walrus)

General characteristics: ear opening obvious, but without external pinna; testes in inguinal region, between blubber and abdominal muscles.



Stranding frequency by region

Walrus (*Odobenus rosmarus*)[32,69,116]

Range: **1** (northern, winter); **2** (northern, occasional); **10** (north of Bering Str. summer and autumn only; main breeding areas, Bering Sea).

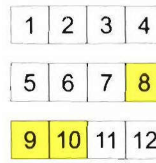
Size: 1-1.4 m, 35-85 kg (neonate); 2 m, 350 kg (weaning); 2.3-2.6 m, 560-1000 kg (adult female); 2.7-3.2 m, 900-1600 kg (adult male).

Distinguishing features: Squarish head with large moustachial pad and many short stiff vibrissae; enlarged upper canines (tusks); thick, wrinkled skin with short hair; tail contained in fold of skin. Teeth: I1/0, C1/1, PC3/3 each side.

Habits: Highly gregarious; females and young mostly segregated from adult males in nonbreeding season; calving Apr.-June; molting June-Oct.; coastal to offshore on sea ice, using shore haulouts in summer and autumn.

Family Otariidae (Fur Seals and Sea Lions)

General characteristics: body form generally slender with long neck; small ear pinna present; foreflippers long, hairless in most species, with rudimentary nails set back from tips of digits; testes scrotal. Teeth: I3/2, C1/1, PC5/5 or 6/5 each side.



Stranding frequency by region

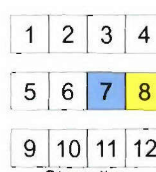
Northern fur seal (*Callorhinus ursinus*)[4,41,138]

Range: **8** (San Miguel I. year-round); **9** (winter-spring, offshore); **10** (summer-fall); breeding areas, Pribilof Is. and San Miguel I.

Size: 0.6 m, 4.5-6 kg (neonate); 12-14 kg (weaning); 1-1.5 m, 30-60 kg (adult female); 1.9-2.3 m, 180-270 kg (adult male).

Distinguishing features: Pelage with coarse outer guard hairs and soft, dense underfur; fur on foreflipper stops at wrist; snout short, down-curved and pointed; males brown, females dark gray and lighter gray or chestnut ventrally; neonates black; extreme sexual dimorphism, adult males with massive neck and bushy mane.

Habits: Coastal to pelagic (offshore in winter); migratory; rookeries on offshore islands; pupping June-Aug.; rarely on land (and nongregarious) outside of breeding season.



Stranding frequency by region

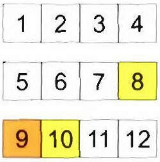
Guadalupe fur seal (*Arctocephalus townsendi*)[7,37]

Range: **6**; **7**; **8** (South of Farallon I.); breeds on Guadalupe I., possibly beyond.

Size: 0.6 m (neonate); 1.4-1.7 m, 40-55 kg (adult female); 1.8-2.4 m, 160-220 kg (adult male).

Distinguishing features: Pelage with dense underfur; fur on forelimb extending onto flipper; snout long and pointed; color grayish black.

Habits: Coastal, preferring rocky areas and caves; rookeries on land; gregarious; pupping June-July; weaning at 9-11 months.



Stranding frequency by region

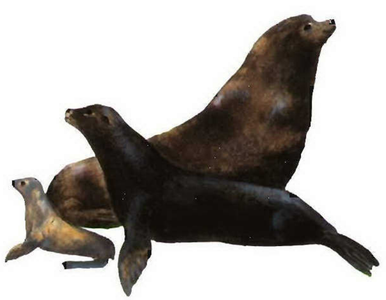
Steller sea lion (*Eumetopias jubatus*)[48,66,113]

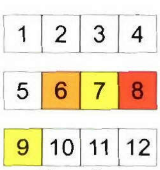
Range: **8**; **9**; **10** (Aleutian Is. and Bering Sea); breeding range from Pribilof Is. to central California (Año Nuevo I.).

Size: 1 m, 16-23 kg (neonate); 1.8 m (weaning); 2.2-2.9 m, 190-350 kg (adult female); 2.4-3.3m, 410-1100 kg (adult male).

Distinguishing features: Pelage with sparse underfur; gap between 4th and 5th postcanines; color light tan to reddish brown, pups darker brown; pronounced sexual dimorphism; adult males with moderately developed sagittal crest, more muscular neck with mane of longer hair; roar-like vocalizations.

Habits: Coastal to pelagic; gregarious year-round; pupping May-July, weaning within one year; haul-out sites and rookeries on land; often on land outside of breeding season.





Stranding frequency by region

California sea lion (*Zalophus californianus*)[45,82]

Range: **6**; **7**; **8**; **9** (to Vancouver I., mostly males); primary breeding range from Channel Is. southward to central Mexico.

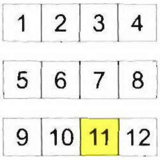
Size: 0.7 m, 6-9 kg (neonate); 25 kg (weaning); 1.5-2 m, 50-110 kg (adult female); 2-2.4 m, 250-390 kg (adult male).

Distinguishing features: Pelage with sparse underfur; no gap between 4th and 5th postcanines; color dark brown, juveniles and females lighter; extreme sexual dimorphism, males with prominent sagittal crest, more muscular neck; sharp bark-like vocalizations.

Habits: Coastal, entering estuaries; rookeries and haul-out sites on land; pupping May-June, weaning usually within 10-12 months; gregarious year-round; often on land in mixed groups outside breeding season.

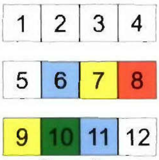
Family Phocidae (Hair Seals)

General characteristics: body fusiform and rotund, with short, thick neck; pinna absent; hind flippers cannot rotate forward; flippers with hair on both surfaces; claws at tips of flippers; testes in inguinal region between blubber and abdominal muscles; 2 or 4 mammary teats.



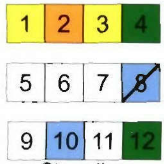
Stranding frequency by region

Hawaiian monk seal (*Monachus schauinslandi*)[55,61]
Range: **11**.
Size: 1 m, 16-18 kg (neonate); 1 m, 56-86 kg (weaning); 2.3-2.4 m, 200-275 kg (adult female); 2.1-2.2 m, 175-230 kg (adult male).
Distinguishing features: Hind flipper with reduced claws, and 1st and 5th digits much longer than middle three; vibrissae smooth; 4 mammary teats; females slightly larger than males; pelage dark gray above, lighter below; neonates black. Teeth: I2/2, C1/1, PC5/5 each side.
Habits: Pupping Jan.-Aug., peak Mar.-May; weaning within 3-7 weeks; molt May-Sept.; nongregarious; frequently haul out on sandy beaches.



Stranding frequency by region

Northern elephant seal (*Mirounga angustirostris*)[71,125]
Range: **7-8** (Baja California northward, primary range of adult females); **9-10** (to eastern Aleutians, spring-fall, mostly juveniles and males); breeds in northern **7** and **8**.
Size: 1.2-1.4 m, 30-45 kg (neonate); 100-160 kg (weaning); 2-3.2 m, 600-900 kg (adult female); 3.8-4.1 m, 1200-2300 kg (adult male).
Distinguishing features: Hind flipper with reduced claws and 1st and 5th digits much longer than middle three; adult males with inflatable proboscis that may overhang mouth; 2 mammary teats; males larger than females; color gray to brown with no markings; neonates black; adult males with thick, cracked and scarred skin on the neck and chest. Teeth: I2/1, C1/1, PC5/5 each side.
Habits: Highly gregarious; feed offshore; pupping and molting haulouts on land; pupping Jan.-Feb.; weaning within 28 days; molt May-Aug.



Stranding frequency by region

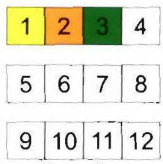
Hooded seal (*Cystophora cristata*)[17,99]

Range: **1** (Dec.-Apr.); **2** (occasional); breeding areas in Davis Str., Gulf of St. Lawrence, and off northeastern Newfoundland.

Size: 0.9-1.1 m, 15-25 kg (neonate); 2-2.3 m, 150-300 kg (adult female); 2.3-2.9 m, 200-400 kg (adult male).

Distinguishing features: Hind flipper with 1st and 5th digits much longer than middle three; adult males with inflatable hood extending from crown of head to upper lip, and inflatable nasal sac; adult males larger than adult females; 2 mammary teats; body gray with irregular black patches, face dark; neonates blue-gray on back, white on belly, with dark face. Teeth: I2/1, C1/1, PC5/5 each side.

Habits: Migratory; associated with offshore pack ice, area **1**; occur in small family groups; pupping Mar.-Apr.; weaning at 4 days; molt June-Aug.



Stranding frequency by region

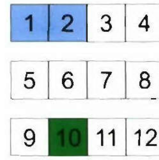
Gray seal (*Halichoerus grypus*)[11]

Range: **1**; **2** (Nantucket I. northward); breeding range from southern Nova Scotia to Gulf of St. Lawrence and Sable I., isolated colony on Nantucket I.

Size: 0.8-1.1 m, 11-20 kg (neonate); 1.1 m, 40-45 kg (weaning); 1.8-2.1 m, 100-250 kg (adult female); 2.2-2.5 m, 170-400 kg (adult male).

Distinguishing features: Hind flipper with 1st and 5th digits slightly longer than middle three; foreflippers with long, slender, curved nails and 3rd digit shorter than 1st and 2nd; vibrissae beaded, slender and curled; snout long with straight or convex profile; nostrils W-shaped; eye closer to ear than to nose; 2 mammary teats; males distinctly larger than females; pelage coarsely spotted, with dark spots on a tan-gray background in females, lighter spots on a dark background in males; juvenile coloration less distinct; neonates with white lanugo for 2-3 weeks. Teeth: I3/2, C1/1, PC5/5 or 6/5 each side.

Habits: Prefer remote exposed islands, sandbars, and shoals; feed offshore; pupping (area **1**) Jan.-Feb. on islands or land-fast ice; weaning at 16-21 days; molt May-June.



Stranding frequency by region

Bearded seal (*Erignathus barbatus*)[15,57]

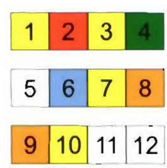
Range: **1** (Newfoundland northward); **2** (unusual); **10** (southward to Bristol Bay in winter); breeds over most of range.

Size: 1.3 m, 35 kg (neonate); 1.5 m, 85 kg (weaning); 2.1-2.5 m, 230-360 kg (adult).

Distinguishing features: Foreflipper broad and squarish with 3rd digit longest; 4 mammary teats; vibrissae smooth, thick, straight and bushy; head proportionately small; back and sides gray, silver-gray on belly; pups grayish brown with irregular white patches; juveniles silver-gray; teeth of adults often worn or missing. Teeth: I3/2, C1/1, PC5/5 each side.

Habits: Solitary or form casual groups; pupping Mar.-May; weaning at 12-18 days; molt May-June; pupping and molting haulouts on pack ice.

Genera *Phoca*, *Pagophilus*, *Pusa*, and *Histriophoca*: general characteristics include hind flipper with 1st and 5th digits slightly longer than middle three; foreflipper with 1st and 2nd digits longer than 3rd; 2 mammary teats; vibrissae beaded, slender and curled; forehead with concave profile and short snout; eye closer to tip of nose than to ear opening; nostrils forming V-shape; sexes of nearly same size; neonates usually with white lanugo.



Stranding frequency by region

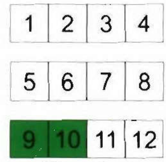
Harbor or common seal (*Phoca vitulina*)[2,9,47]

Range: **1**; **2**; **3-4** (occasional); **7** (north of Guadalajara); **8**; **9**; **10** (Aleutian Is., Pribilof Is., Bristol Bay); breeds throughout most of range (north of New Hampshire on Atlantic coast).

Size: 0.7-0.9 m, 9-15 kg (neonate); 0.9 m, 20-29 kg (weaning); 1.5-1.9 m, 75-120 kg (adult).

Distinguishing features: Snout blunt; color variable (gray to tan to brownish black, with darker spotting); pups gray to tan (white lanugo may be shed after birth in northern populations); pelage on back smooth to touch. Teeth: I3/2, C1/1, PC5/5 each side.

Habits: Coastal year-round, entering rivers and some lakes; commonly haul out on land, sandbars and ledges at low tide; form casual small to large groups; pupping season varies with latitude (Apr.-July area **1**, Mar.-June area **2**, Mar.-May areas **7-8**, Apr.-Aug. area **9**, May-July area **10**); weaning from 3-6 weeks; molt occurs within 2-3 months after pupping season.



Stranding frequency by region

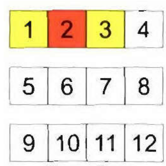
Spotted or larga seal (*Phoca largha*)[9,96]

Range: **10** (winter-spring, along ice front; summer, Bering and Chukchi seas); breeds along ice front.

Size: 0.8-0.9 m, 7-12 kg (neonate); 1.1 m, 36 kg (weaning); 1.6-1.7 m, 80-130 kg (adult).

Distinguishing features: Similar to harbor seal; belly light silver-gray, back and head darker and marked with silver rings, brown to black spots scattered over body; neonates with white lanugo. Teeth: I3/2, C1/1, PC5/5 each side.

Habits: Solitary or form small groups on ice; groups to 2000 or more on summer land haulouts; pupping and molting haulouts on pack ice; pupping Feb.-May; weaning from 4-6 weeks; molt May-June.



Stranding frequency by region

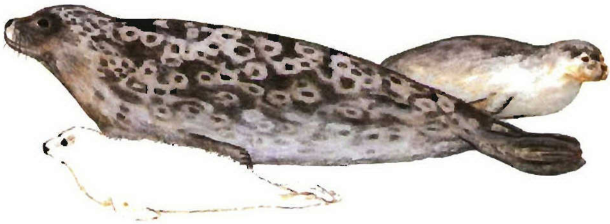
Harp seal (*Pagophilus groenlandicus*)[109,118]

Range: **1** (Dec.-May); **2** (uncommon); breeding areas in Gulf of St. Lawrence and off northeast coast of Newfoundland.

Size: 0.8-1.1 m, 7-12 kg (neonate); 1 m, 30-35 kg (weaning); 1.6-1.9 m; 120-180 kg (adult).

Distinguishing features: Dark harp-shaped pattern on back and sides, white to tan background (pattern less distinct in females), dark head; neonates with white lanugo, older pups gray to tan with darker spots. Teeth: I3/2, C1/1, PC5/5 each side.

Habits: Migratory; pupping and molting on pack ice; scattered during breeding, gregarious during migration and molt; pupping late Feb. to mid-Mar.; weaning at about 12 days; molt Apr.-May.



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5	6	7	8
9	10	11	12

Stranding frequency by region

Ringed seal (*Pusa hispida*)[59,72,121]

Range: **1** (Labrador northward, occasionally to Gulf of St. Lawrence); **10** (Beaufort and Chukchi seas; Bering Sea north of Bristol Bay); breeds over most of range.

Size: 0.6-0.7 m, 4-4.5 kg (neonate); 0.8 m, 9-16 kg (weaning); 1.2-1.5 m, 60-100 kg (adult).

Distinguishing features: Head narrow with somewhat pointed nose; back dark gray with light rings, belly silver-gray; neonates with white lanugo; older pups dark gray above, silvery below; pelage on back coarse, harsh to touch. Teeth: I3/2, C1/1, PC5/5 each side.

Habits: Prefer stable land-fast ice in winter and spring; non-gregarious, forming casual groups; pupping mid-Mar. to May in snow-covered lairs; weaning at 6-8 weeks; molt from May-July on fast or pack ice.

1	2	3	4
5	6	7	~~8~~
9	10	11	12

Stranding frequency by region

Ribbon seal (*Histriophoca fasciata*)[16,58]

Range: **10** (Bering and Chukchi seas; winter-spring, offshore along ice front; summer range unknown); breeds along ice front.

Size: 0.8-0.9 m, 9-11 kg (neonate); 0.9-1.1 m, 22-30 kg (weaning); 1.5-1.8 m, 80-145 kg (adult).

Distinguishing features: Adult males with white bands on dark brown to black background, females with less distinct bands on lighter background; neonates with white lanugo; juveniles blue-gray on back, paler ventrally. Teeth: I3/2, C1/1, PC5/5 each side.

Habits: Pelagic; non-gregarious; pupping and molting on pack ice; pupping Apr.-May; weaning at 3-4 weeks; molt late Mar.-July.

15.2. CETACEANS

Order Cetacea, Suborder Mysticeti (Baleen Whales)

General characteristics: upper jaw with baleen plates rather than teeth; lower jaw robust, without teeth; blowholes paired.

Family Eschrichtiidae

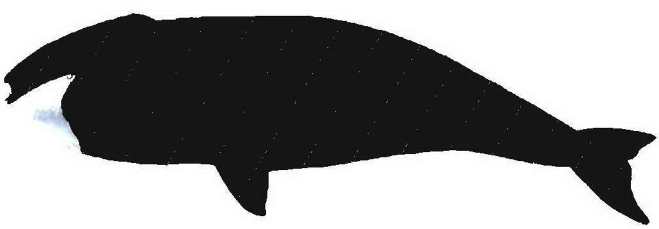
1	2	3	4
5	6	7	8
9	10	11	12

Stranding frequency by region

Gray whale (*Eschrichtius robustus*)[135]
Range: **6**, mid-**7** (late Dec.-Mar.); northern **7**, **8**, **9** (Mar.-May, Oct.-Dec., few in summer); **10** (June-Sept.).
Size: 4.6-5 m, 500-680 kg (neonate); 8.5 m (weaning); 11-15 m, 16-35 t (adult).
Distinguishing features: Head narrow and tapering, no central ridge; rostrum with many pits, each with 1 hair; barnacle encrustations common, heavy on head; dorsal fin absent, series of low bumps (7-12) along posterior dorsal midline; skin mottled gray; baleen short (<0.3 m), white to yellowish, 130-180 plates/side; 2-5 creases on throat.
Habits: Coastal south of Alaska, more offshore in northern feeding grounds; strongly migratory; calving Dec.-Feb. in areas **6** and **7**; weaning at 7-9 months.

Family Balaenidae (Right Whales)

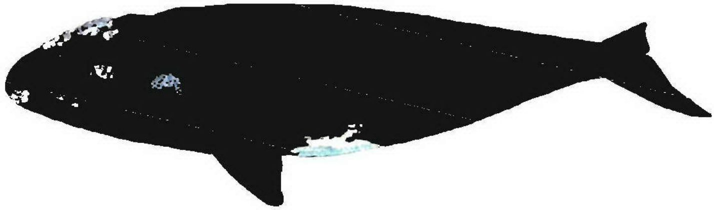
General characteristics: body form robust; head large (>25% body length); upper jaw narrow and highly arched, with long baleen plates; dorsal fin absent; flippers broad; throat grooves absent.

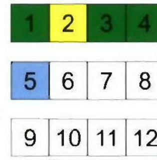


1	2	3	4
5	6	7	8
9	10	11	12

Stranding frequency by region

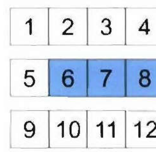
Bowhead whale (*Balaena mysticetus*)[98]
Range: **1** (Labrador northward); **10**.
Size: 4-4.5 m, 900 kg (neonate); 6.1 m (weaning); 15-20 m, 70-100 t (adult).
Distinguishing features: Skin smooth with no callosities; flippers broad and spatulate; body black with white on chin and sometimes peduncle; baleen plates (to 3.7-4.3 m) usually black, 230-360 plates/side.
Habits: Coastal and offshore, mostly along ice fronts and leads; migratory.





Stranding frequency by region

North Atlantic right whale (*Eubalaena glacialis*)[25]
Range: **1** (May-Nov.); **2** (Mar.-Nov.); **3-4** (Dec.-Mar.); **5** (rare offshore, Jan.-Mar.).
Size: 4-4.6 m, 900 kg (neonate); 15-17 m, 45-90 t (adult).
Distinguishing features: Lower jaw and head with numerous rough callosities; flippers large and rounded; skin mostly black, often with white patches on chin and belly; baleen plates (<2.8 m) dark with fine bristles, 200-270 plates/side.
Habits: Frequent coastal waters; females and calves inshore in areas **3-4**, Jan.-Mar.; migratory.

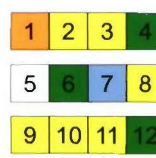


Stranding frequency by region

North Pacific right whale (*Eubalaena japonica*)[25]
Range: **7-11** (rare).
Size: See above.
Distinguishing features: See above.
Habits: Frequent coastal waters; migratory; calving areas in eastern North Pacific unknown.

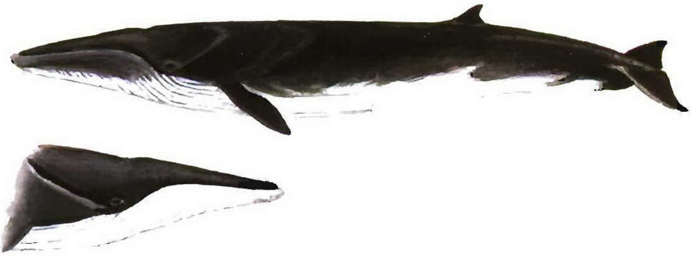
Family Balaenopteridae (Rorquals)

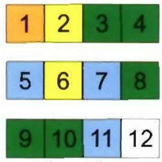
General characteristics: body form more slender; head broad and flattened with 1 or 3 dorsal ridges; jaw not highly arched, baleen short to moderate in length; dorsal fin present; flippers narrow; throat grooves numerous.



Stranding frequency by region

Humpback whale (*Megaptera novaeangliae*)[21,22,134]
Range: **1-2** (peak summer); **3**; **4** (Jan.-May); **5** (offshore, winter); **6** (year-round); southern **7** (winter); northern **7-10** (summer); **11** (peak Dec.-Apr.); **12** (Jan.-May).
Size: 4-4.6 m, 680-1400 kg (neonate); 8-10 m (weaning); 12-16 m, 30-45 t (adult).
Distinguishing features: Jaws and head with numerous knobs, often barnacle encrusted; fleshy mass near tip of lower jaw; dorsal fin on hump, 2/3 back on body; flippers large (to 1/3 body length); flukes long, with sawtoothed margin; body dark gray to black, white on throat; throat grooves (12-36) wide, extending to navel; baleen short (<0.7 m), black with dark brownish gray bristles, 270-400 plates/side.
Habits: Coastal in many areas; strongly migratory; often in groups of 2-10; weaned at 10-12 months.





Stranding frequency by region

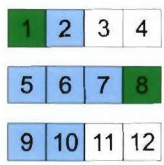
Fin whale (*Balaenoptera physalus*)[38]

Range: **1**-northern **2** (spring-summer); **2-3** (year-round, peak Apr.-Oct.); **4** (winter, offshore); **5** (year-round); **6** (year-round); **7** (winter); **8-10** (summer); **11** (winter); **12** (winter, offshore).

Size: 6-6.5 m, 1.8-2 t (neonate); 11 m (weaning); 20-24 m, 50-80 t (adult).

Distinguishing features: Head flattened and wedge-shaped; dorsal fin (to 0.6 m) falcate, about 2/3 back on body; strong dorsal ridge anterior to tail; body gray to brownish above, white below; lower right jaw white, left dark; baleen (<0.7 m) dark gray and yellow striped, but white to yellow anterior right side, 260-470 plates/side; throat grooves (56-100) extend at least to navel.

Habits: Generally pelagic, visiting coastal waters in many areas; migratory; occur singly or in small groups; weaning at 6-8 months.



Stranding frequency by region

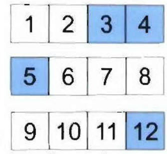
Blue whale (*Balaenoptera musculus*)[137]

Range: **1** (Apr.-Aug.); **2-3** (rare); **6** (spring and fall); **7**-southern **9** (spring-fall); northern **9**-southern **10** (summer).

Size: 7-8 m, 2-3.6 t (neonate); 12.8-16 m, 23 t (weaning; 22-26 m, 100-150 t (adult).

Distinguishing features: Head broad, rostrum U-shaped, central ridge short; dorsal fin small (<0.25 m), 3/4 back on body; body dark blue-gray with pale mottling; flippers pointed, white below; baleen (<0.9 m) black with dark, coarse bristles, 270-400 plates/side; tongue and palate black; throat grooves (55-88) extend at least to navel.

Habits: Pelagic, but may frequent coastal waters and shallow banks; migratory; weaning at 6-8 months; occur singly or in groups of 2-3.



Stranding frequency by region

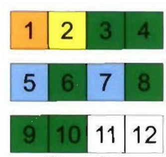
Sei whale (*Balaenoptera borealis*)[39]

Range: **1-2** (May-Oct.); **3**; **4**; **5**; **6-7** (peak Dec.-Mar.); **8-9** (summer-fall); southern **10** (summer); **12**.

Size: 4.5 m, 680 kg (neonate); 9 m (weaning); 15-19 m, 15-35 t (adult).

Distinguishing features: Dorsal fin (0.3-0.6 m) falcate, about 2/3 back on body; body gray to blue-gray above, lighter below, often with light oval scars; flukes dark below; baleen (<0.8 m) black with fine white to grayish-brown bristles, 220-400 plates/side; throat grooves (32-60) ending between flipper and navel.

Habits: Pelagic; northward shift in summer; weaning at 6-7 months; occur singly or in small groups.



Stranding frequency by region

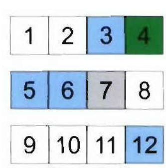
Minke whale (*Balaenoptera acutorostrata*)[124]

Range: **1-2** (Apr.-Nov.); **3** (winter, offshore); **4**; **5** (winter, offshore, uncommon); **6**; **7** (winter); **8-9** (year-round); **10** (summer); **11** (Leeward Is.); **12**.

Size: 2.4-2.8 m, 320 kg (neonate); 4.5-5.5 m (weaning); 7-9 m, 6-9 t (adult).

Distinguishing features: Head narrow and pointed with sharp median ridge; dorsal fin falcate, prominent; body black above, white below; may have chevron markings behind head; flipper small with broad white band; baleen short (<0.3 m), white to yellowish with fine white bristles, 230-360 plates/side; throat grooves (50-70) extending nearly to navel.

Habits: Frequent coastal regions, bays, and offshore banks; northward shift in summer; weaning at 4-6 months; often occur singly, sometimes in groups of 2-3.



Stranding frequency by region

Bryde's whale (*Balaenoptera edeni*)[24]

Range: **3**; **4**; **5**; **6**; **7**, southern **8** (rare); **11**; **12** (summer-fall).

Size: 3.4-4 m, 680 kg (neonate); 7.1 m (weaning); 13-15.5 m, 12-20 t (adult).

Distinguishing features: Head with 3 prominent ridges anterior to blowhole; dorsal fin (to 0.5 m) strongly curved with pointed tip; body dark gray; baleen short (<0.4 m), dark gray with coarse bristles, 250-370 plates/side; throat grooves (40-50) extend at least to navel.

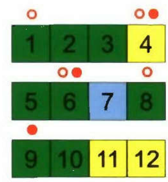
Habits: Variable habits: some pelagic populations migratory, some resident in nearshore waters; weaning at 6 months; occur singly or in pairs.

Suborder Odontoceti (Toothed Whales)

General characteristics: teeth present in one or both jaws (only in adult males of some species); blowhole single.

Family Physeteridae (Sperm Whales)

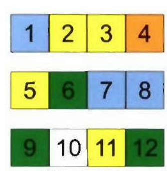
General characteristics: head blunt or squarish with blowhole to left of midline; lower jaw narrow and underslung; functional teeth in lower jaw only.



Stranding frequency by region

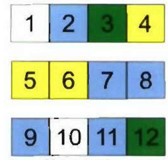
Sperm whale (*Physeter macrocephalus*)[105]
Range: **1-2** (summer-fall); **3**; **4**; **5**; **6** (southern); **7-8** (peak Nov.-Apr.); **9** (spring-fall); southern **10** (summer, males); **11** (year-round); **12**.
Size: 3.5-4 m, 1 t (neonate); 6.7 m, 2.7 t (weaning); 9-12.5 m, 12-20 t (adult female); 15-18 m, 36-57 t (adult male).
Distinguishing features: Huge square head with blowhole near left tip; lower jaw narrow with large conical teeth; dorsal fin hump-like, followed by smaller bumps along dorsal ridge; flippers small and blunt; body dark brownish gray, skin "corrugated;" throat with short furrows. Teeth: 0-3/20-26 each side.
Habits: Generally pelagic; highly social, sexually segregated herds of up to 40-50; migratory, with larger males moving into higher latitudes, females and juveniles usually remaining south of 50° N; old males solitary.

Family Kogiidae (Pygmy Sperm Whales)



Stranding frequency by region

Pygmy sperm whale (*Kogia breviceps*)[19,20]
Range: **1-2** (rare north of Cape Cod); **3**; **4**; **5**; **6**; **7**; **8**; southern **9**; **11**; **12**.
Size: 1-1.2 m, 55 kg (neonate);2.7-3.4 m, 320-410 kg (adult).
Distinguishing features: Body chunky, tapering to narrow tailstock; small lower jaw with sharp curved teeth; "false gill" marking posterior to eye; dorsal fin very small (<0.2 m), about 2/3 back on body; flippers short and broad, located forward on body; no throat creases; body dark blue-gray to brownish on back, lighter on sides, white on belly. Teeth: 0-3/12-16 each side.
Habits: Pelagic; occur singly or in small groups; peak calving fall to spring.

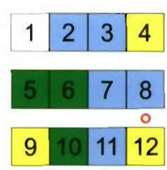


Stranding frequency by region

Dwarf sperm whale (*Kogia sima*)[19,20,78]
Range: **3**; **4**; **5**; **7-8** (rare further north); **11**; **12**.
Size: 1 m, 46 kg (neonate); 2.1-2.7 m, 140-270 kg (adult).
Distinguishing features: Similar to *K. breviceps* but body smaller, dorsal fin taller and near midback; several short creases in throat. Teeth: 0-3/8-11 each side.
Habits: Pelagic; occur singly or in small groups.

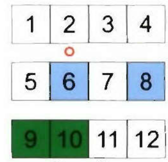
Family Ziphiidae (Beaked Whales)

General characteristics: teeth (1 or 2 pairs) in lower jaw only; beak distinct, lower jaw often extending beyond upper; throat with two creases forming a "V"; flippers small; median notch in flukes indistinct or absent; dorsal fin small, more than 1/2 way back on body; wide crescent-shaped blowhole.



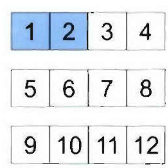
Stranding frequency by region

Cuvier's beaked whale (*Ziphius cavirostris*)[46,133]
Range: **2-3** (summer); **4**; **5**; **6**; **7**; **8**; **9**; **10** (Aleutians); **11** (rare); **12**.
Size: 2-3 m, 250-300 kg (neonate); 5.5-7 m, 2-3 t (adult).
Distinguishing features: Forehead sloping to poorly defined beak; depression behind blowhole; dorsal fin about 2/3 back on body; lower jaw of adult males with 1 pair of conical teeth protruding from tip (unerupted in females and juveniles); color variable, gray or brown to tan to white, lighter with age; white scratches and round scars common.
Habits: Pelagic; occur singly or in groups of up to 20-30.



Stranding frequency by region

Baird's beaked whale (*Berardius bairdii*)[6,133]
Range: **7-8** (peak June-Oct.); **9** (Apr.-Oct.); southern **10** (winter).
Size: 4.5 m (neonate); 10-12 m, 9-11 t (adult).
Distinguishing features: Body long and rotund; melon prominent, steeply sloping to long cylindrical beak; dorsal fin small, triangular, >2/3 back on body; adults with 2 pairs of laterally flattened teeth near tip of lower jaw, anterior pair visible with mouth closed; throat creases to 70 cm long, some with small central crease; color black to brown to gray with white patches ventrally; heavily scarred.
Habits: Pelagic; occur in groups of 2-20 with some segregation of sexes.



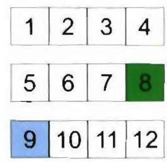
Stranding frequency by region

Northern bottlenose whale (*Hyperoodon ampullatus*)[74]
Range: **1** (year-round, peak fall-winter); **2** (occasional, fall-winter).
Size: 3-3.5 m (neonate); 8-9.5 m, 3-7.5 t (adult).
Distinguishing features: Body robust; melon bulbous, sloping sharply to a prominent beak; lower jaw with 1 pair of teeth at tip (erupted in adult males only), not visible with mouth closed; dorsal fin falcate, about 2/3 back on body; body black to brown above, lighter below, with various lighter markings in adults; head of adults light.
Habits: Pelagic; occur singly or often in groups of 4-10.

Mesoplodon spp.

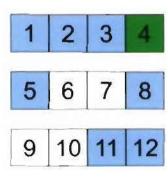
General characteristics in addition to those of the Ziphiidae: only 1 pair of laterally flattened teeth, erupted in adult males only, often on an arched prominence on the lower jaw; body generally spindle-shaped with a small head and narrow tailstock; color dark above and light below; blowhole in depression behind the melon, which slopes to a long beak; body wall with pocket-like depressions for flippers; adults, particularly males, frequently heavily scarred.

NOTE: Several species of this genus may be found in North American waters and are rare, not well-known, and difficult to identify in the field. Identification of females and immature males, in which teeth are unerupted, is even more difficult.



Stranding frequency by region

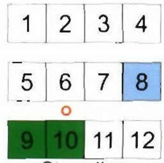
Hubb's beaked whale (*Mesoplodon carlhubbsi*)[73,133]
Range: northern **7**; **8**; southern **9**.
Size: 2.5 m (neonate); 5.3 m, 1.4 t (adult).
Distinguishing features: Adult males with notable white raised area anterior to blowhole; tip of beak white; teeth massive, flat and wide, protruding from raised arches about 1/2 way from tip of jaw to angle of mouth; throat creases long; body heavily scarred.
Habits: Pelagic; occur in small groups.



Stranding frequency by region

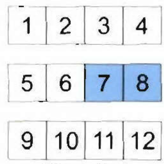
Blainville's beaked whale (*Mesoplodon densirostris*)[68,73]
Range: **1**; **2**; **3**; **4**; **5**; **7**; **8**; **11**; **12**.
Size: 2-2.5 m, 60-150 kg (neonate); 4.5-4.7 m, 1 t (adult).
Distinguishing features: Forehead flattened with marked depression anterior to blowhole; teeth protrude from front edge of prominent arch near corner of mouth and tilt forward; skin of adults scarred; body dark on back, lighter gray ventrally and on sides, with blotchy gray to pinkish markings and white oval scars.
Habits: Pelagic; occur in small groups.

Stejneger's beaked whale (*Mesoplodon stejnegeri*)[73,131,133]
Range: **8**; **9**; **10**.
Size: 2.1-2.3 m (neonate); 5-5.4 m, 1.6-1.9 t (adult).
Distinguishing features: Teeth large and flattened, protruding from arches near middle of lower jaw and tilting slightly forward; top of head has no raised white area; back with ridge from dorsal fin to flukes.
Habits: Pelagic; occur in small groups.

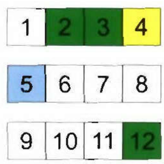


Stranding frequency by region

Ginkgo-toothed beaked whale (*Mesoplodon ginkgodens*)[73,85]
Range: **7**- southern **8** (rare).
Size: 2.1 (neonate); 4.8-5.2 m, 1.5 t (adult).
Distinguishing features: Upper jaw narrow and pointed; teeth large, wide and flattened, located about halfway between tip of lower jaw and corner of mouth, on top front edge of prominent arch; area anterior to blowhole neither markedly depressed nor raised; body dark with numerous white blotches and oval scars on belly.
Habits: Pelagic.



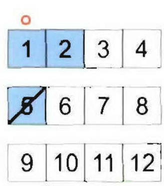
Stranding frequency by region



Stranding frequency by region

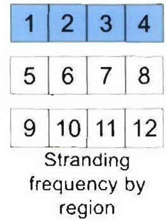
Gervais' beaked whale (*Mesoplodon europaeus*)[68,73,80,110]
Range: **2**; **3**; **4**; **5**; **12**.
Size: 2.1 m (neonate); 4.5-5.2 m (adult female); 4.5-4.8 m (adult male); 1.2 t (adult).
Distinguishing features: Body laterally compressed; head extremely small with narrow beak; teeth triangular, about 1/3 back from tip of lower jaw.
Habits: Oceanic; occur in small groups; calving likely in spring and summer; most common *Mesoplodon* to strand on the US Atlantic coast.

Sowerby's beaked whale (*Mesoplodon bidens*)[10,73]
Range: **1**; **2**.
Size: 2.1-2.4 m, 170 kg (neonate); 3 m (weaning); 4.7-5.5 m, 1.3 t (adult).
Distinguishing features: Teeth small and pointed, about 1/2 way from tip of lower jaw to corner of mouth.
Habits: Pelagic; occur in small groups.



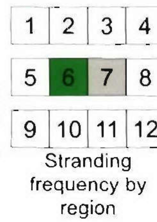
Stranding frequency by region

True's beaked whale (*Mesoplodon mirus*)[68,73]



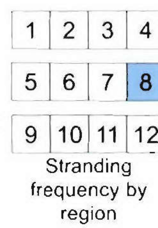
Range: **1** (summer); **2**; **3**; **4**.
Size: 2.2 m (neonate); 5.1-5.4 m, 1.4 t (adult).
Distinguishing features: Body heavy, with depression behind blowhole and slightly bulging melon; teeth small, triangular and compressed, located near tip of lower jaw.
Habits: Pelagic.

Pygmy beaked whale (*Mesoplodon peruvianus*)[104,128]



Range: **6**; **7**.
Size: <1.6 m (neonate); 3.3-3.9 m (adult)
Distinguishing features: Smallest *Mesoplodon*; short beak; dorsal fin small, triangular to falcate; deep gray on back and sides, lighter gray below; calves may have brown coloring, including eye patch.
Habits: Pelagic.

Perrin's beaked whale (*Mesoplodon perrini*)[27]

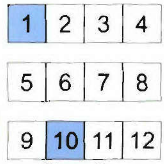


Range: **8**.
Size: <2.4 m (weaning); 3.9-4.4 m (adult).
Distinguishing features: Beak short; teeth small and triangular, near tip of lower jaw.
Habits: Pelagic.

Family Monodontidae

General characteristics: dorsal fin absent, replaced by low dorsal ridge; flippers paddle-shaped; melon prominent; beak indistinct.

Beluga whale (*Delphinapterus leucas*)[12,44]
Range: **1** (Labrador northward; St. Lawrence River estuary, Gulf of St. Lawrence); **2** (occasional strays, winter); northern **9**; **10**.
Size: 1.3-1.6 m, 50-80 kg (neonate); 3-4 m, 500-900 kg (adult female); 4-4.5 m, 900-1400 kg (adult male).
Distinguishing features: Body rotund with small head, bulbous melon, and well-defined flexible neck; beak short; color dark gray in juveniles, light gray to white in adults. Teeth: 8-11/8-9 each side.
Habits: Coastal in bays, estuaries and rivers; migratory along leads; winter offshore in pack ice; gregarious in small to large groups.



Stranding frequency by region

Narwhal (*Monodon monoceros*)[43]

Range: **1** (Labrador northward); **10** (rare).

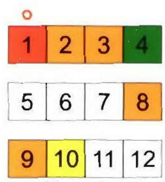
Size: 1.5-1.7 m, 80 kg (neonate); 4.2-4.7 m, 1000-1600 kg (adult).

Distinguishing features: Body rotund with small head and no beak; males with a spiral tusk up to 3 m long; newborn blotchy gray; adults dark purplish black with white mottling on backs and sides and white bellies, becoming lighter with age.

Habits: Usually associated with pack ice and deep water; occur singly or in small to large groups.

Family Phocoenidae (Porpoises)

General characteristics: body small with triangular or rounded dorsal fin; snout rounded with indistinct beak; teeth spade-shaped.



Stranding frequency by region

Harbor porpoise (*Phocoena phocoena*)[40,97]

Range: **1**, **2** (common inshore Apr.-Oct.); **3**; **4** (rare); **8**; **9**; **10** (southern in winter).

Size: 0.7-0.9 m, 5-6 kg (neonate); 1-1.1 m (weaning); 1.4-1.7 m, 60-80 kg (adult).

Distinguishing features: Dorsal fin broad-based, low and triangular; flippers small and blunt; back, flippers, flukes and tailstock black to brown; sides gray, belly white. Teeth: 21-29/20-29 each side.

Habits: Coastal in bays, estuaries and rivers; frequent offshore banks; weaning at 8-12 months; occur singly, in pairs, or in small groups.

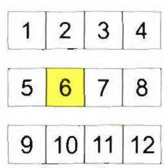
Vaquita (*Phocoena sinus*)[13,40,130]

Range: **6** (northern).

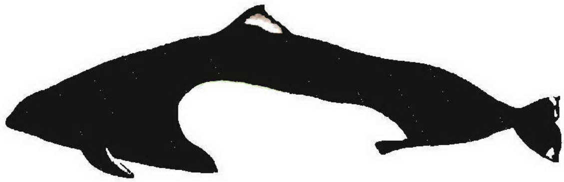
Size: 0.7 m. 7.5 kg (neonate); 1.3-1.5 m, 40-50 kg (adult).

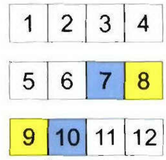
Distinguishing features: Similar to harbor porpoise, with distinct black lip and eye patches and larger, more erect dorsal fin; range limited to northern Gulf of California. Teeth: 16-22/17-20.

Habits: Coastal; calving late winter to early spring, peak Mar.-Apr.; occur singly, in pairs, or in small groups.



Stranding frequency by region



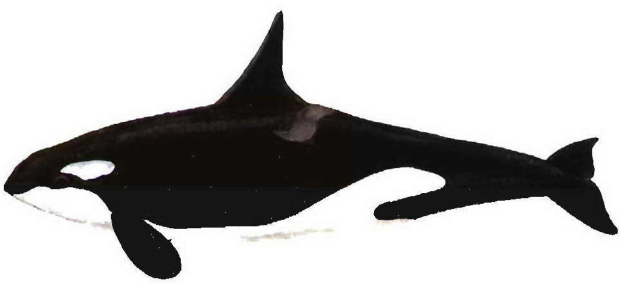


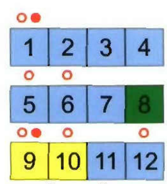
Stranding frequency by region

Dall's porpoise (*Phocoenoides dalli*)[34,40,49,50]
Range: northern **7** (inshore winter-spring); **8**; **9**; **10** (south of Bering Strait).
Size: 1 m, 11-25 kg (neonate); 1.8-2.2 m, 100-200 kg (adult).
Distinguishing features: Heavy body with very small head, mouth, flippers and flukes; tailstock with prominent dorsal and ventral keels; distinct black and white color pattern. Teeth: 21-28/21-28 each side.
Habits: Pelagic; nearshore in deep water; occur in small groups, occasionally in large aggregations.

Family Delphinidae

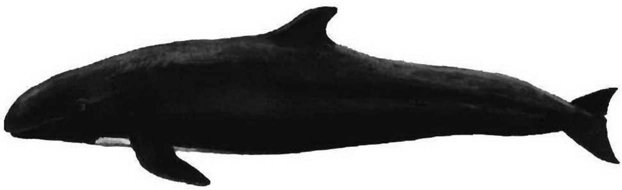
General characteristics: teeth in both jaws (except for *Grampus*); teeth conical, not spade-shaped; dorsal fin usually well developed; beak variable.

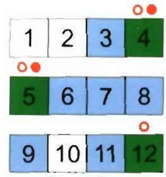




Stranding frequency by region

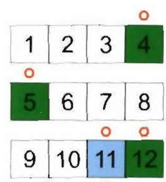
Killer whale (*Orcinus orca*)[3,26]
Range: **1** (inshore peak spring-summer); **2** (occasional); **3-5** (uncommon); **6**; **7**; **8**; **9** (inshore year-round); **10** (north of Bering Strait in summer only); **11** (rare); **12**.
Size: 2.1-2.5 m, 180 kg (neonate); 4 m (weaning); 7-8 m, 4 t (adult female); 8-9 m, 5.6-8 t (adult male).
Distinguishing features: Body heavy with blunt, indistinct beak; dorsal fin at midback, high (to 1.8 m) and triangular in males, smaller and more curved in females; flippers broad and rounded; striking black and white coloration with oval white patch above and behind eye; teeth large, squarish in cross-section. Teeth: 10-12/10-12 each side.
Habits: Common inshore visitors; regularly coastal only in **9-10**; occur commonly in pods of 10-40; strong social organization.





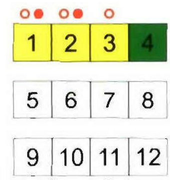
Stranding frequency by region

False killer whale (*Pseudorca crassidens*)[84,123]
Range: **3**; **4**; **5**; **6** (occasional); **7**; **8-9** (occasional); **11**; **12**.
Size: 1.6-1.9 m, 80 kg (neonate); 4.6-5 m (adult female); 5.2-6 m, 900-1400 kg (adult male).
Distinguishing features: Body long and slender; head rounded and tapering with no beak and long straight mouthline; flipper long, narrow and pointed, with notable hump at middle of leading edge; dorsal fin near midbody, moderately high and falcate; color black except for variably distinct gray anchor-shaped area between flippers. Teeth: 7-12/7-12 each side.
Habits: Pelagic; highly social, form large schools.



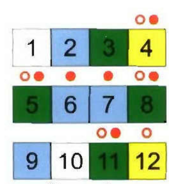
Stranding frequency by region

Pygmy killer whale (*Feresa attenuata*)[70,111]
Range: **4**; **5**; southern **7**; **11**; **12**.
Size: 0.8 m (neonate); 2.1-2.6 m, 155-230 kg (adult).
Distinguishing features: Body slender with rounded head, no beak, and straight mouthline; dorsal fin falcate, placed at midback; flippers with convex anterior margin, rounded at tip; color dark on back, lighter on sides and belly; anchor-shaped light area between flippers, white patches on abdomen, lips and chin. Teeth: 8-11/10-13 each side.
Habits: Pelagic; occur in small groups (usually <50).



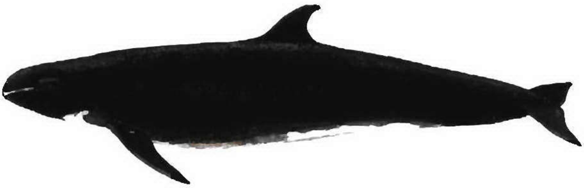
Stranding frequency by region

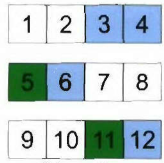
Long-finned pilot whale (*Globicephala melas*)[8,117]
Range: **1**; **2**; **3**; **4** (northern, rare).
Size: 1.6-1.9 m, 70-90 kg (neonate); 2.4 m (weaning); 3.8-5 m, 800-1200 kg (adult female); 5-6 m, 1200-2000 kg (adult male).
Distinguishing features: Head with bulbous melon and indistinct beak; dorsal fin long-based, low, and strongly curved with rounded tip, located forward on the body; pectoral fins long (>1/5 body length) and sickle-shaped; color black with light anchor-shaped patch on throat and variable lighter markings on belly. Teeth: 9-12/9-12 each side.
Habits: Pelagic, moving inshore late summer and fall; highly social, in small groups (<50) to large herds (>200); often associates with other cetaceans.



Stranding frequency by region

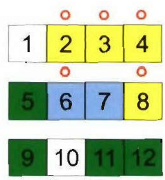
Short-finned pilot whale (*Globicephala macrorhynchus*)[5,8,70]
Range: southern **2-3** (summer); **4**; **5**; **6**; **7**-southern **8** (inshore peak late winter/early spring); northern **8-9** (uncommon); **11**; **12**.
Size: 1.4 m, 60 kg (neonate); 4-5 m, 600-1200 kg (adult female); 4.6-6 m, 1200-1800 kg (adult male).
Distinguishing features: Similar to above, but with shorter (<1/5 body length) pectoral fins. Teeth: 7-9/7-9 each side.
Habits: Generally pelagic; highly social, in small groups (<50) to large herds (>200); often associates with other cetaceans.





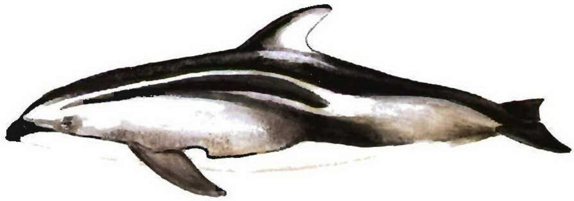
Stranding frequency by region

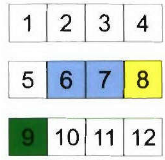
Melon-headed whale (*Peponocephala electra*)[51,94]
Range: **4** (rare); **5**; **7** (rare); **11**; **12** (rare).
Size: 1 m, 15 kg (neonate); 2.3-2.7 m, 200-275 kg (adult).
Distinguishing features: Body slender; head triangular from above; beak indistinct; mouthline long and straight; flippers with convex anterior margin, pointed at tips; dorsal fin falcate, slender, and sharply pointed; color black above with anchor-shaped gray patch on throat and white areas on abdomen and lips. Teeth: 20-26/20-26 each side.
Habits: Pelagic; occur in small groups to large herds (>1000 animals); often associates with other cetaceans.



Stranding frequency by region

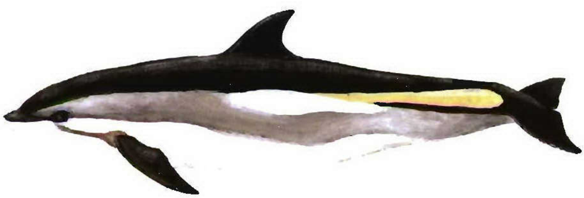
Risso's dolphin (*Grampus griseus*)[63]
Range: **1-2** (uncommon north of Cape Cod); **3**; **4**; **5**; **6**; **7-8** (year-round); southern **9** (spring-fall); **11** (rare); **12**.
Size: 1.1-1.5 m (neonate); 3-4 m, 300-500 kg (adult).
Distinguishing features: Body heavy anteriorly, tapering to narrow tailstock; head blunt with no distinct beak, but with unique vertical crease in melon; dorsal fin tall and pointed, near midback; flippers long and pointed; color light to dark gray with numerous white scars, becoming lighter with age; flippers, flukes and dorsal fin darker; no teeth in upper jaw. Teeth: 0/2-7 each side.
Habits: Pelagic; occur singly or in small to large groups (usually <40), occasionally in large herds; commonly associates with other cetaceans.

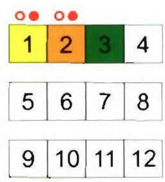




Stranding frequency by region

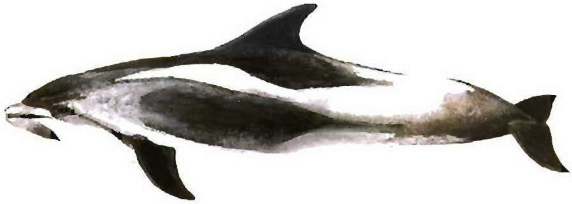
Pacific white-sided dolphin (*Lagenorhynchus obliquidens*)[14]
Range: **6** (southern); **7-8** (peak winter-spring); **9**; **10** (Aleutian Is., summer).
Size: 0.8-1 m (neonate); 2.1-2.5 m, 145-200 kg (adult).
Distinguishing features: Head short with short beak; flippers long and tapered; dorsal fin at about midback, tall, sharply hooked and bicolor; color pattern distinct with black back, elongated light gray area above flipper and light stripe along side, and white belly; beak dark with stripe from mouth to flipper. Teeth: 23-36/25-35 each side.
Habits: Generally pelagic; nearshore in deep water; occur in small groups to schools of thousands; often associates with other cetaceans.

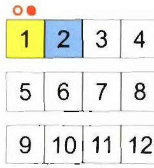




Stranding frequency by region

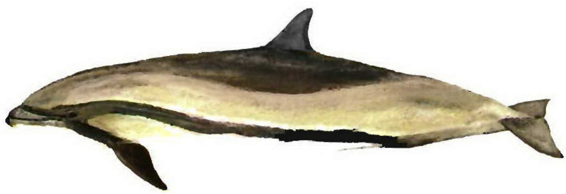
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)[100]
Range: **1-2** (common inshore spring-autumn); **3** (uncommon).
Size: 1-1.3 m, 20 kg (neonate); 2.2-2.7 m, 180-235 kg (adult).
Distinguishing features: Beak short; dorsal fin tall and sharply falcate; flippers strongly curved and pointed; tailstock with prominent dorsal and ventral keels; sides of body with distinct elongated white patch followed by one of tan or yellow; flippers, back, and short beak black, dorsal fin black and gray, flank lighter gray, belly white; dark stripe from flipper to dark part of body. Teeth: 30-40/30-40 each side.
Habits: Pelagic but may feed in deep water close to shore; may occur singly, in small groups (<50) or in schools of several hundred; often associates with other cetaceans.

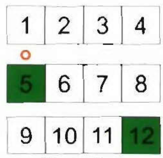




Stranding frequency by region

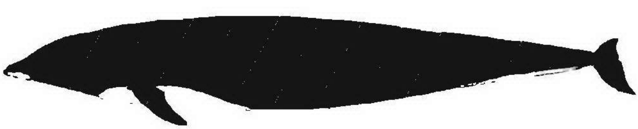
White-beaked dolphin (*Lagenorhynchus albirostris*)[101]
Range: **1-2** (Nov.-June).
Size: 1.1-1.3 m (neonate); 2.8-3.1 m, 255-350 kg (adult).
Distinguishing features: Large size; dorsal fin tall and falcate; flippers slightly curved; beak often white or light gray; body dark on back and sides, light gray to white below, with white markings on back and sides; dorsal fin black. Teeth: 22-28/22-28 each side.
Habits: Pelagic; occur in small groups or large schools (>1000).

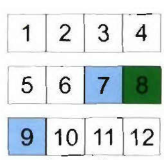




Stranding frequency by region

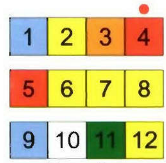
Fraser's dolphin (*Lagenodelphis hosei*)[52,76,93]
Range: **4-5** (rare); **11**; **12**.
Size: 1 m, 19 kg (neonate); 2.4-2.7 m 130-210 kg (adult).
Distinguishing features: Body heavy; beak short; flippers small; dorsal fin triangular, small and pointed; tailstock with dorsal and ventral keels; back blue-gray, belly white; adults with dark stripe from rostrum to anus. Teeth: 36-44/34-44 each side.
Habits: Pelagic; occur in small groups to large schools; often associates with other cetaceans.





Stranding frequency by region

Northern right whale dolphin (*Lissodelphis borealis*)[53,54]
Range: **7**; southern **8** (inshore winter-spring); **8** (offshore year-round); southern **9** (uncommon).
Size: 0.8-1 m (neonate); 2-2.3 m (adult female); 2.6-3 m (adult male); 90-115 kg (adult).
Distinguishing features: Body slender and smooth; no dorsal fin; slender beak demarcated by faint crease; long straight mouthline; body mainly black, some white on ventral surface and near tip of lower jaw. Teeth: 37-54/37-54 each side.
Habits: Generally pelagic; nearshore in deep water; highly gregarious, commonly in schools of several hundred; often associates with other cetaceans.



Stranding frequency by region

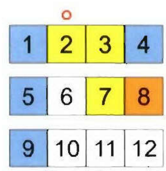
Bottlenose dolphin (*Tursiops truncatus*)[107,132]

Range: **1-2** (summer offshore, uncommon); **3**; **4**; **5**; **6**; **7**; **8** (rare further north); **11**; **12**.

Size: 0.8-1.3 m, 10-20 kg (neonate); 2.5-3 m, 140-240 kg (adult coastal form); 3.3-3.8 m, 250-650 kg (adult offshore form).

Distinguishing features: Body robust; head with distinct thick beak; dorsal fin moderately high and falcate, near midback; flippers tapering to point; body gray to black above, becoming lighter ventrally. Teeth: 20-26/18-24 each side.

Habits: Frequents bays and estuaries in southern regions; weaning after 18-24 months; generally offshore in areas **1-3**; occur in small to large groups.



Stranding frequency by region

Short-beaked common dolphin (*Delphinus delphis*)[31,87]

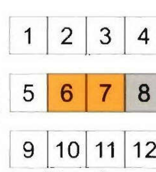
Range: **1** (summer); **2**; **3**; **4**; **7**-southern **8** (year-round); northern **8** (uncommon); **9** (rare); **12** (uncertain).

Size: 0.8-1 m (neonate); 1.7-2.3 m, 80-200 kg (adult).

Distinguishing features: Beak well-defined; dorsal fin tall and pointed, triangular to falcate, near midback; body with complex yellow/tan and gray crisscross pattern on sides; back black, belly white; beak often black with white tip; narrow black stripe from flipper to mid lower jaw and from eye across base of melon. Teeth: 40-54/40-54 each side.

Habits: Generally pelagic; commonly in groups of <50, sometimes in large schools (>1000).

Long-beaked common dolphin (*Delphinus capensis*)[31,87]



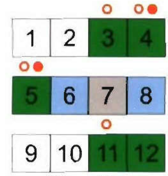
Stranding frequency by region

Range: **6**; **7**; southern **8**; **12** (uncertain).

Size: 0.8-1 m (neonate); 1.9-2.5 m, 80-235 kg (adult).

Distinguishing features: Easily confused with *D. delphis*. Long beak, dorsal fin tall and pointed, triangular to falcate, near midback; coloration similar to *D. delphis* but more subdued. Teeth: 47-67/47-67 each side.

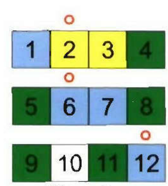
Habits: Prefers shallower, warmer water than *D. delphis*; often in groups of <200, sometimes in large schools (>1000).



Stranding frequency by region

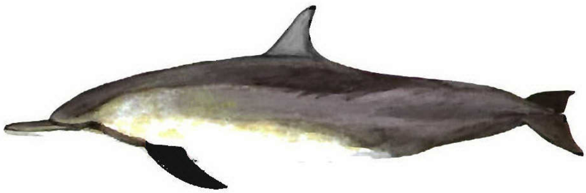
Rough-toothed dolphin (*Steno bredanensis*)[33,77]
Range: **3-5**; **7-8** (uncommon); **11**; **12**.
Size: 1 m (neonate); 2.3-2.7 m, 130-160 kg (adult).
Distinguishing features: Forehead sloping without crease to long slender beak; dorsal fin tall and falcate with long base; flippers large and tapered; color dark gray or purple-brown with pink or yellowish white spots on sides; belly and lips white; light scratches, circular scars common. Teeth: 20-27/20-27 each side.
Habits: Pelagic; generally occur in small groups of 10 to 20.

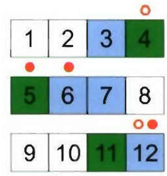
NOTE: Dolphins of the genus ***Stenella*** have long slender beaks, many small teeth, and various patterns of stripes and spots. The great variation among stocks can make identification difficult.



Stranding frequency by region

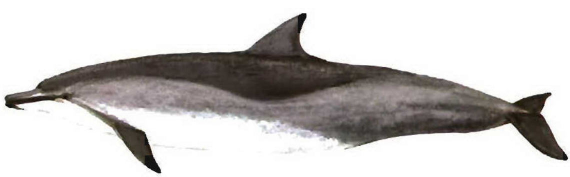
Striped dolphin (*Stenella coeruleoalba*)[1]
Range: **1** (southern, rare); **2**; **3**; **4**; **5**; **6**; **7**; **8**; southern **9** (rare); **11**; **12**.
Size: 1 m, 11 kg (neonate); 1.4-1.7 m (weaning); 2.2-2.6 m, 100-160 kg (adult).
Distinguishing features: Body slender; beak long and sharply defined; color pattern distinct with dark back, lighter gray sides, white to gray belly and throat, and black stripes from eye to anus and eye to flipper; tall, curved dorsal fin; fin, flukes and flippers dark. Teeth: 38-59/37-55 each side.
Habits: Pelagic; form herds up to several hundred.

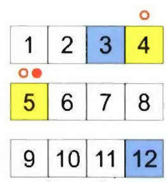




Stranding frequency by region

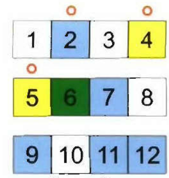
Spinner dolphin (*Stenella longirostris*)[86,89]
Range: **3**; **4-5** (common); **6**; **7**; **11**; **12**.
Size: 0.7-0.8 m (neonate); 1.8-2.2 m, 75-95 kg (adult).
Distinguishing features: Body slender; head with long narrow beak; dorsal fin triangular to falcate; body dark gray dorsally, lighter on sides, white on belly; beak dark on top, white below, with black tip and black lips; black stripe from flipper to eye. Teeth: 44-64/42-62 each side.
Habits: Pelagic and coastal; daytime in shallow bays in **11**; form large herds; often associates with other *Stenella* spp.





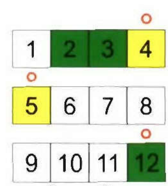
Stranding frequency by region

Clymene dolphin (*Stenella clymene*)[35,91]
Range: southern **2**; **3**; **4**; **5**; **12**.
Size: 1.8-2 m, 75 kg (adult).
Distinguishing features: Similar to *S. longirostris*, but beak short, caudal peduncle moderately keeled, and coloration pattern more complex, particularly on head (dark band across beak, another along top of beak to melon; light band continues over melon to blowhole); black on back not extending to tailstock; white stripe from eye to flipper and darker stripe running forward along flanks from anus. Teeth: 39-49/38-48 each side.
Habits: Pelagic in small to large groups.



Stranding frequency by region

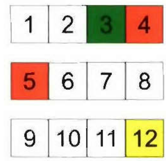
Pantropical spotted dolphin (*Stenella attenuata*)[90]
Range: **2-3** (uncommon); **4**; **5**; **6**; **7**; **11**; **12**.
Size: 0.8-1 m (neonate); 1.4 m (weaning); 1.6-2.6 m, 90-120 kg (adult).
Distinguishing features: Beak long and sharply defined; dorsal fin tall and curved; flippers pointed; young unspotted, dark gray above and light gray below; darker spots appear on belly, enlarging and merging with age; lighter spots appear on dorsal cape and sides; peduncle dark above, light below; degree of spotting and details of flipper and eye stripes highly variable among stocks; approx. 80 vertebrae. Teeth: 35-48/34-47 each side.
Habits: Offshore stocks often occur in large schools (>1000), coastal populations in smaller groups (<30).



Stranding frequency by region

Atlantic spotted dolphin (*Stenella frontalis*)[88,92]
Range: **2** (southern); **3**; **4**; **5**; **12**.
Size: 0.8-1.2 m (neonate); 1.4 m (weaning); 1.7-2.3 m, 100-145 kg (adult).
Distinguishing features: Similar to above, but heavier-bodied; ventral margin of cape obscured by pale blaze extending along sides from head to below dorsal fin; ventral background white rather than gray; adults become heavily spotted, obscuring background pattern; peduncle not divided into upper dark and lower light halves; flipper stripe demarcated above by narrow light line; approx. 70 vertebrae. Teeth: 32-42/30-40 each side.
Habits: Generally pelagic; commonly occur in groups of about 5 to 50.

15.3. SIRENIANS



Stranding frequency by region

West Indian manatee (*Trichechus manatus*)[18,23,36,42]

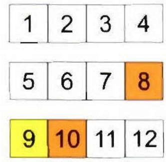
<u>Subspecies</u>

Florida manatee (*Trichechus manatus latirostris*)
Range: **3** (uncommon); **4**; **5** (northeastern)

Antillean manatee (*Trichechus manatus manatus*)
Range: **5** (southern); **12**

Size: 1.1-1.5 m, 30 kg (neonate); 3.5-4.1 m, 1000-1620 kg (max. adult).
Distinguishing features: Large bulky body tapering to a spatulate tail; mobile forelimbs with 3-4 nails; body gray to brown, nearly black in newborn; thick, wrinkled skin; prominent facial vibrissae.
Habits: Protected shallow coastal waters, estuaries, rivers where aquatic vegetation is abundant.

15.4. SEA OTTERS



Stranding frequency by region

Sea otter (*Enhydra lutris*)[30,60,108,112,126]

<u>Subspecies</u>

Northern sea otter (*Enhydra lutris kenyoni*)
Range: **9**; **10** (Aleutian Is.)

Southern sea otter (*Enhydra lutris nereis*)
Range: Northern **7** (rare); **8**

Size: 0.5-0.6 m, 1.0-2.3 kg (neonate); 10-14 kg (weaning); 1.2-1.4 m, 16-32 kg (adult female); 1.3-1.5 m, 27-45 kg (adult male).

Distinguishing features: Body elongated and heavy; pelage dense, light buff to brown to nearly black; head and shoulders often lighter; newborns with light brown woolly coat, darkening by about 3 months; hind limbs with fully webbed feet, 5th digit the longest. Males distinguishable from females by the penile and testicular bulge and more muscular head and neck; only females are known to carry pups. Adult dental formula: I3/2, C1/1, P3/3, M1/2.

Habits: Coastal, often associated with kelp beds and rocky bottom habitats; generally remain at surface when not diving for food.

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Appendix A
Cetacean/Pinniped Necropsy Report (Sample)

Field Number: ____________________ Accession Number: ______________________

Species: ____________________________________ Date: ______________

Sex: ______ Length: ____________ Weight: ____________ Age: ____________

Prosectors: ____

Brief History: (Date of Death: _______________ Time of Death, if known: __________)

Tentative Diagnosis:

Final Diagnosis:

MEASUREMENTS (cm unless indicated) * = Required

Cetaceans

* Snout to melon ______________
Snout to angle of mouth ______________
* Snout to blowhole ______________
Snout to center of eye ______________
Snout to fin tip ______________
* Snout to fluke notch ______________
Snout to caudal end of ventral grooves ______________
* Snout to center of anus ______________
Snout to center of genital aperture ______________
* Snout to anterior insertion of flipper ______________
Snout to anterior insertion of fin ______________
* Flipper length ______________
* Flipper width ______________
* Fin height ______________
* Fluke width ______________

Girth: *Axillary ___________ Maximum (location) ____________ Anal ___________

Blubber thickness (excluding epidermis), location: _______________________________

Dorsal _____________ Lateral __________________ *Ventral ________________

Pinnipeds

* Standard length ______________
Curvilinear length ______________
* Ant. length, front flipper ______________
* Ant. length, hind flipper ______________

Girth: *Axillary ___________ Maximum (location) ____________ Anal ___________

Blubber thickness (excluding epidermis), location: _______________________________

Dorsal _____________ Lateral __________________ *Ventral ________________

Field Number: ____________________ Accession Number: ____________________

Species: ____________________ Date: ______________ Sex: ___________

BALEEN/TOOTH COUNTS

UL __________ LL __________ UR __________ LR __________

CONDITION: Alive Freshly dead Moderately decomposed

Extremely decomposed Other

EXTERNAL EXAMINATION

General condition (lesions, deformities, appearance, color):

Photo _____
Histo _____
Other _____

Parasites:

Mouth / Teeth:

Eyes:

Blowhole / Nostrils:

Anus and Urogenital openings:

Mammary slits / glands:

Fins / Flukes / Flippers:

PRIMARY INCISION

(Note general condition and position of internal organs and tissues; quantity and color of observed fluids.)

Photo _____
Histo _____
Other _____

Blubber:

Thorax:

Abdomen:

MUSCULOSKELETAL

Photo _____
Histo _____
Other _____

Muscle:

Skeletal:

Vertebral epiphyses:

open _____ mm / closed, visible _____ / closed, invisible _____

Field Number: ______________________ Accession Number: ______________________

Species: ________________________ Date: _______________ Sex: ____________

RESPIRATORY

Upper:

Lower:

Cranial sinuses:

Photo _____
Histo _____
Other _____

CIRCULATORY

Heart (if carcass is fresh, collect blood aseptically from the right ventricle):

Great vessels:

Blood:

Photo _____
Histo _____
Other _____

LYMPHATIC

Spleen:

Lymph nodes:

Thymus:

Photo _____
Histo _____
Other _____

ENDOCRINE

R. Adrenal:

L. Adrenal:

Thyroid:

Pituitary:

Photo _____
Histo _____
Other _____

URINARY

R. Kidney:

L. Kidney:

Bladder (empty/full/urine saved):

Photo _____
Histo _____
Other _____

DIGESTIVE

Esophagus:

Stomach:

Stomach contents:

Intestines (Length _____ m):

Fecal exam:

Liver:

Pancreas/Pancreatic ducts:

Gall bladder/Hepatopancreatic duct:

Photo _____
Histo _____
Other _____

Field Number: ______________________ Accession Number: ______________________

Species: ________________________ Date: ________________ Sex: ____________

REPRODUCTIVE

Photo	_____
Histo	_____
Other	_____

R. Gonad:

L. Gonad:

Sperm/Corpora:

Penis:

Uterus (vaginal mucus: Y N)

R. Mammary (milk saved: Y N)

L. Mammary (milk saved: Y N)

Reproductive Condition:

Pregnant/Fetus (sex = ____, weight = ______, length = ______):

Lactating:

NERVOUS/SENSORY

Photo	_____
Histo	_____
Other	_____

Eyes:

Spinal cord:

Peripheral:

Brain:

Ear sinuses (parasites):

Carcass disposition:

Comments:

Field Number: ____________________ Accession Number: ____________________

Species: ____________________ Date: ________________ Sex: ____________

TISSUE SAMPLE CHECKLIST

Samples	Chem/ Tox	Biol Tox	Histo	Life Hist/ Genetics	Photos	Parasit	Clinical Studies	Bact	Virology/ PCR	Voucher	Morpho-metrics
adrenal											
bladder											
blood, whole											
blood, serum											
blubber											
bone											
bone marrow											
brain											
eyes											
feces											
gonads											
heart											
kidney											
liver											
lung											
lymph node (specify)											
mammary											
muscle											
pancreas											
pituitary											
skin/epidermis											
skull											
spleen											
stomach											
stomach cont.											
teeth											
thymus											
thyroid											
tonsils											
urine											
uterus											
other											

Appendix B
NOAA Marine Mammal Stranding Report, Level A Data Form

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

FIELD #: ____________ **NMFS REGIONAL #:** ____________ (NMFS USE) **NATIONAL DATABASE #:** ____________ (NMFS USE)

COMMON NAME: ____________ **GENUS:** ____________ **SPECIES:** ____________

EXAMINER Letterholder: ____________

Name: ____________ Affiliation: ____________

Address: ____________ Phone: ____________

LOCATION OF INITIAL OBSERVATION

State: ______ County: ____________

City: ____________

Body of Water: ____________

Locality Details: ____________

Latitude: ____________ N ☐ actual

Longitude: ____________ W ☐ estimated

How lat/long determined (Check ONE)

☐ GPS

☐ Map

☐ Internet/Software

OCCURRENCE DETAILS ☐ Restrand GE#: ____________ (NMFS USE)

Group Event: ☐ YES ☐ NO

If Yes, Type: ☐ Cow/Calf Pair ☐ Mass Stranding # Animals: ______ ☐ actual ☐ estimated

Findings of Human Interaction ☐ YES ☐ NO ☐ Could not Be Determined (CBD)

If Yes, Check one or more: ☐ 1. Boat Collision ☐ 2. Shot ☐ 3. Fishery Interaction

☐ 4. Other Human Interaction: ____________

Describe How Determined: ____________

Gear Collected? ☐ YES ☐ NO Gear Disposition: ____________

Other Findings upon Level A: ☐ YES ☐ NO ☐ CBD

If Yes, Check one or more ☐ 1. Illness ☐ 2. Injury

☐ 3. Other Findings: ____________

Describe How Determined: ____________

INITIAL OBSERVATION

Date: Year: ______ Month: ____________ Day: ____________

First Observed: ☐ Beach or Land ☐ Floating ☐ Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)

☐ 1. Alive ☐ 4. Advanced decomposition

☐ 2. Fresh dead ☐ 5. Mummified/Skeletal

☐ 3. Moderate decomposition ☐ 6. Unknown

LEVEL A EXAMINATION ☐ Not Able to Examine

Date: Year: ______ Month: ____________ Day: ____________

CONDITION AT EXAMINATION (Check ONE)

☐ 1. Alive ☐ 4. Advanced decomposition

☐ 2. Fresh dead ☐ 5. Mummified/Skeletal

☐ 3. Moderate decomposition

Available at http://www.nmfs.noaa.gov/pr/readingrm/MMHealth/LevelA2004-FINAL.pdf. Accessed August 2005.

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)

☐ 1. Left at Site
☐ 2. Immediate Release at Site
☐ 3. Relocated
☐ 4. Disentangled
☐ 5. Died at Site
☐ 6. Euthanized at Site
☐ 7. Transferred to Rehabilitation:
Date:________ Facility:__________
☐ 8. Died during Transport
☐ 9. Euthanized during Transport
☐ 10. Other:__________

CONDITION/DETERMINATION (Check one or more)

☐ 1. Sick
☐ 2. Injured
☐ 3. Out of Habitat
☐ 4. Deemed Healthy
☐ 5. Abandoned/Orphaned
☐ 6. Inaccessible
7. Location Hazardous:
☐ a. To animal
☐ b. To public
☐ 8. Unknown/CBD
☐ 9. Other:__________
Comments:__________

MORPHOLOGICAL DATA

SEX (Check ONE)
☐ 1. Male
☐ 2. Female
☐ 3. Unknown

AGE CLASS (Check ONE)
☐ 1. Adult
☐ 2. Subadult
☐ 3. Yearling
☐ 4. Pup/Calf
☐ 5. Unknown

Straight Length: ________ ☐ cm ☐ in ☐ actual ☐ estimated
Weight:________ ☐ kg ☐ lb ☐ actual ☐ estimated

PHOTOS/VIDEOS TAKEN: ☐ YES ☐ NO
Photo/Video Disposition: __________

TAG DATA

Tags Were:
Present at Time of Stranding (pre-existing): ☐ YES ☐ NO
Applied during Stranding Response: ☐ YES ☐ NO

ID #	Color	Type	Placement* (Circle ONE)	Applied	Present
			D DF L LF LR RF RR	☐	☐
			D DF L LF LR RF RR	☐	☐
			D DF L LF LR RF RR	☐	☐

* D = Dorsal; DF = Dorsal Fin; L = Lateral Body
LF=Left Front; LR = Left Rear; RF = Right Front; RR = Right Rear

WHOLE CARCASS STATUS (Check one or more)

☐ 1. Left at site
☐ 2. Buried
☐ 3. Rendered
☐ 4. Towed: Lat________Long______
☐ 5. Sunk: Lat________Long______
☐ 6. Frozen for Later Examination
☐ 7. Landfill
☐ 8. Unknown
☐ 9. Other:______

SPECIMEN DISPOSITION (Check one or more)

☐ 1. Scientific collection
☐ 2. Educational collection
☐ 3. Other:__________
Comments:__________

NECROPSIED ☐ YES ☐ NO Date:__________

NECROPSIED BY:__________

NOAA Form 89-864 (rev. 2004)
OMB No 0648-0178; Expires August 31, 2007

Appendix C
Marine Forensics Chain of Custody Form

Field reference number: ______________________________

Laboratory reference number: ______________________________

Geographical origin of sample: ______________________________

Name & signature of sample collector: ______________________________

Address of sample collector: ______________________________

____

Collector's phone number: ______________ Date collected: __________

Seized property number (if applicable): ______________________________

Sample description: ______________________________

____

The above sample was transferred as follows:

1. ______________________________ __________
Collector's release signature Method of transfer Date

______________________________ __________
Receipt signature Date

2. ______________________________ __________
Release signature Method of transfer Date

______________________________ __________
Receipt signature Date

3. ______________________________ __________
Release signature Method of transfer Date

______________________________ __________
Receipt signature Date

4. ______________________________ __________
Release signature Method of transfer Date

______________________________ __________
Receipt signature Date

5. ______________________________ __________
Release signature Method of transfer Date

______________________________ __________
Receipt signature Date

Each person in possession of the sample must sign and date the form twice, once for receipt of the sample and once for release.

Modeled after chain of custody form from National Marine Fisheries Service, SEFSC, Charleston Lab, 219 Ft. Johnson Rd., Charleston, SC 29412.

Appendix D
Condensed Protocol for Evaluating Marine Mammals for Signs of Human Interaction

Adapted from a document developed by the Cape Cod Stranding Network and Virginia Aquarium & Marine Science Center with funding from the John H. Prescott Grant Program. To obtain the complete document and further information, contact kt2e@capecodestranding.net or sgbarco@virginiaaquarium.com.

Introduction

Evaluating marine mammals for signs of human interaction requires consistent, objective examination by trained personnel. This new protocol is divided into an objective data collection section and a more subjective final diagnosis. The primary goal of this protocol is to determine whether evidence of human interaction is present on the animal. The secondary, and more difficult, goal is to determine whether human activities contributed to the stranding event. This evaluation does not attempt to determine whether the signs of human interaction occurred before, during or after a stranding event and does not attempt to qualify the severity of the interaction.

The final human interaction evaluation takes into account the circumstances of the stranding event and the animal's physical condition. A high score indicates that human activities most likely caused the stranding. A low score indicates that although signs of human interaction are present, the likelihood that the interaction caused the stranding is very low.

Determining the cause of death is not an objective of this protocol. Without further evaluation and review by veterinarians, pathologists and/or other experts, the exact reason for stranding and cause of death cannot be accurately determined.

Human interaction (HI) data illustrate where problems between marine mammals and humans occur. When collected carefully and consistently, these data can be used to describe the types of interaction taking place, thus providing a sound scientific basis for policy and management decisions. The nature of strandings makes it inadvisable to use human interaction data to estimate fishery bycatch rates, total bycatch, or changes in bycatch.

Explanation of terms

For most of the sections, choose among the following answers:

YES the anatomical area was examined and signs of human interaction were found

NO the area was examined and no signs of human were found

CBD (Could not Be Determined) either (1) the area was examined, but examiner could not determine whether marks (or signs) indicated human interaction, (2) the area was degraded and could not be examined, or (3) the area could not be examined because it was missing

NE the area was not examined, explain why in *Comments*

NA question is not applicable to this animal

Strategy for filling out the data sheet

Each new line on the data sheet is numbered in the left hand margin. These numbers serve two purposes: (1) each number corresponds to a section within these instructions with details about how to fill in that line; (2) the line numbers should be entered in the comments section on the second page of the data sheet to indicate to which item the comment refers.

Exam Information: Fill in or circle the most appropriate answer for each of the fields.

1 Field # - unique ID number assigned to the animal by response personnel. Record this number on each side of all forms pertaining to the animal. The field number NEVER changes. If other filing or accession numbers are added, note them as "additional identifiers".

Species - genus and species of animal.

2 Examiner - person evaluating the animal.

Recorder - person recording information.

3 Date of exam - date of human interaction evaluation.

Condition Code (at exam) - condition code of animal at time of human interaction evaluation. Use Smithsonian Institution condition codes (*see* **10.3.3**).

4 Preservation - ALIVE, FRESH (not previously frozen), FROZEN (partially or completely frozen at exam), or FROZEN/THAWED (previously frozen, but completely thawed before exam)

Body condition - EMACIATED (clearly thin, concave epaxial muscle, obvious neck, ribs, scapulae, hip bones, and/or vertebral processes), NOT EMACIATED (robust or slightly thin, but not fitting the description of emaciated above) or CBD (Could not Be Determined)

5 Documentation - circle all forms of photo/video documentation that apply

Image disposition - indicate camera, disk, etc. used for images and by which organization

6 Integument (skin, fur, hide) - NORMAL, ABNORMAL (conditions not associated with decomposition such as fur loss, lesions, sloughing, abrasions, etc.), or DECOMPOSED/SCAVENGED (postmortem changes such as peeling, sunburn, or scavenger damage).

% Skin missing: Circle most appropriate value. This does not apply to alopecia (fur loss).

7 See *Explanation of Terms* above

WHOLE BODY EXAM: Before beginning a detailed exam, look at the whole animal from all possible angles and surfaces. Following the exam, check the most appropriate choice for each category. For areas marked YES or CBD, give further details in the *Comments* section, noting the appropriate line number. Indicate whether an image of an area was taken with Y (Yes) or N (No) in the *Image Taken* column. If unable to examine any areas, note details in the *Comments* section.

8 Head/appendages removed (with instrument) - YES: obvious straight line cuts, straight nicks to the bone, or other signs the head or other appendages were removed with an instrument. NO: all appendages are intact. CBD: unsure why appendage is missing (e.g. possibly removed by scavenging or predation).

9 Pelt removed (with instrument) - YES: appears to have been removed with an instrument. NO: pelt is intact (even if hair/fur is missing). CBD: unsure (due to decomposition, etc.). NA: animal has no pelt (cetacean or manatee).

10 Body sliced (with instrument) - YES: carcass sliced with one or more cuts (multiple parallel cuts often indicate propeller wounds and should be noted under *HI Lesions*). NO: body is intact or open body cavity is obviously due to natural causes. CBD: body cavity has been penetrated, unsure of cause.

11 Gear/debris present on animal - YES: animal is entangled. NO: no gear/debris on animal. CBD: unsure (e.g. gear/debris is found on, but not around the animal, or gear/debris was reported but apparently removed before response).

12 Gear retained - YES: gear retained by stranding network or NOAA enforcement official, note name and contact information. NO: gear was not retained. NA: no gear/debris present on animal.

13 External pathology - YES: animal has pox lesions, tattoo lesions, abscesses, or other unexplained lumps, bumps or sores that appear to be disease-related. NO: animal has no disease-related lesions. CBD: unsure of lesion origin or integument is too degraded to assess.

14 Natural marking - YES: animal has tooth rakes, unusual pigmentation, or other natural markings (non-HI scars), note if natural marks hamper examination in the *Comments*. NO: no natural markings. CBD: cannot distinguish any marks or unsure of marking's origin.

15 HI lesions - Note other lesions that may be associated with human interaction (healing or healed entanglement or propeller scars, gaff marks, etc.). YES: other human interaction lesions. NO: no other lesions. CBD: lesions present, but unsure of their origin or integument is too degraded to assess.

16 Predation/scavenger damage - If there is evidence of predation or scavenger damage, circle the number(s) that correspond to the appropriate anatomical areas (17-30). If area affected is not numbered, circle *#30*, and note area in table below (e.g. genital slit, umbilicus) with details of damage in *Comments*.

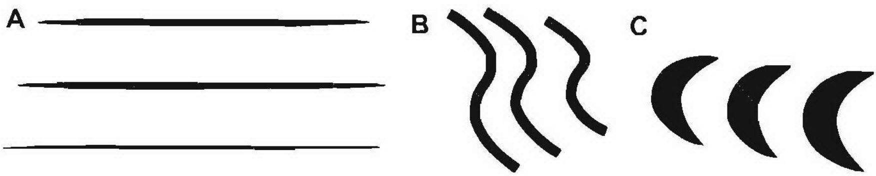

Figure 1: Types of propeller lesions left by different styles and sizes of propeller. The length, depth and spacing between lesions can provide information as to the type of propeller and vessel.

17-29 **DETAILED EXAM OF ANATOMICAL AREAS** - Examine animal carefully starting at head. Work caudally down right side, then left, finishing with tail or flukes. Indicate signs of HI in each anatomical area by checking the YES, NO or CBD column. If unable to examine an area, check NE. If an area does not apply, check NA. Be consistent; examine each carcass in the same manner.

TYPE OF LESION - For anatomical areas marked YES or CBD, check applicable lesion columns.

- Impression - indentation on the skin/pelt. Impressions left by net or line usually wrap around the leading and/or trailing edges of a fin, flipper or fluke. Impressions on the leading edge of an appendage may line up with a similar mark on the trailing edge.
- Laceration - the skin/pelt is cut. Net and line usually leave linear lacerations that may be evenly spaced along an appendage (indicating net) and may be accompanied by impressions.
- Abrasion - Scrapes on the skin/pelt. Often occurs with heavy line or twine entanglement or when loose or trailing ends of gear/debris rub (abrade) parts of the body.
- Other - Describe the lesion in the *Comments* section.

ORIGIN OF LESION - Check all columns that apply.

- Line - Large in diameter with many individual strands (multifilament).
- Twine - Small diameter and can be multi- or monofilament.
  - Monofilament twine - leaves a single, straight, narrow impression or laceration.
  - Multifilament line or twine - leaves a series of parallel, angled line or oval impressions. Can cause abrasions.
  - Net - often characterized by a criss-cross pattern or a bunching of impressions with or without knot marks evident where lines intersect. Nets made of monofilament may leave multiple impressions or lacerations, but each lesion is a straight furrow.

If the lesion was not from line, net, or twine, check the appropriate box to indicate the source:

- Propellers - deep, roughly parallel lacerations. Lesions can be straight (Fig. 1A), S-shaped (Fig. 1B), curved (Fig. 1C), or open in the middle with thin trails (not illustrated). Large vessels may bisect an animal.
- Other - origins of lesions may include gunshot, gaff, dredge, and debris.
- If unsure of the origin of the lesion(s), check the CBD column.

Take pictures or video of every anatomic area that scores YES or CBD and include identifying information (field number, stranding date, species, examiner, subject of image, etc.) and a scale. If film or disk space is not limited, take pictures of all areas. Note Y (yes) or N (no) in the *Image Taken* column.

Record comments for each area that scores YES or CBD with the corresponding line number.

30 If you find lesions in an area not listed in the Detailed Exam table, add the area here and complete the table as explained above.

INTERNAL EXAM: Some forms of interaction (e.g. ingestion of debris or gear) are only evident through internal exam. Also, a final interpretation may change if an animal with external evidence of HI is found to be suffering from disease.

31 Internal examination - YES: able to examine the entire animal. NO: animal was not examined internally. PARTIAL: part of the animal was examined, describe in the *Comments* section.

32 Bruising/blunt trauma - YES: focal areas of bruising are present. If not associated with a penetrating lesion or wound, consider it blunt trauma. Note size of the area and tissue depth (e.g. subdermal to blubber, into muscle, through muscle and into mesenteries and organs) in *Comments*.

33 Skeleton - YES: entire skeleton was examined. NO: no bones were examined. PARTIAL: some of the skeletal elements were examined, note in *Comments* what was examined.

34 Broken bones - Note whether any broken bones were observed.

Associated tissue reaction - Examine the tissue around the break(s) and circle whether any tissue reaction has occurred (hemorrhage, fibrous tissue, swelling at bone ends, etc.). If unsure, check CBD.

35 GI tract - Note any contents in the GI tract. In the *Detailed Info* column, note the predominant condition. Describe the GI tract region and contents description in *Comments*. Stranded animals with full stomachs are often suspect cases. If only a part of the GI tract was examined, check PARTIAL and note which areas in *Comments*.

36 Lung/bronchi - YES: both lungs examined. NO: not examined. PARTIAL: partial examination.

37 Lung/bronchi contents - Circle all that apply under *Detailed Info*. Describe the contents of each lung, including content volume, in the *Comments*.

38 Other pathologies noted - Any other pathologies were observed.

39 Comments - Provide details for each item checked YES or CBD. When describing lesions, include measurements, location, color, shape and texture. Note characteristics of edges (e.g. jagged, straight, rounded) and direction of linear lesions (e.g. wraps from leading edge of dorsal fin to trailing edge). Number each set of comments using the corresponding line number for that row of the data sheet. Use extra pages if needed and be sure to note the animal's field number in the upper right margin.

40 Signs of human interaction observed - YES: signs of HI were observed during the exam. NO: did not find any signs of HI. CBD: animal was not examined thoroughly, decomposition or scavenger damage hampered the exam, or could not determine whether marks on the animal were caused by HI.

This does not take into account the animal's physical condition, the timing of the human interaction with respect to the stranding or the circumstances surrounding the stranding. TRANSFER THIS INFORMATION TO THE LEVEL A DATA SHEET.

41 Stranding event history/circumstances - provide information about the event or circumstances surrounding the event that would be helpful in determining the HI diagnosis (i.e. fishing, dredging, oil spill, unusual mortality event, previous sightings of animal, unusual behavior prior to stranding, etc.). Note details provided by the initial reporter. If harassment is suspected, describe the events and include names and contact numbers for witnesses and any authorities that were contacted.

42 Final human interaction evaluation - Complete this section if YES is marked under #40. This section is subjective and takes into account the animal's physical condition, necropsy findings, timing of the human interaction with respect to the stranding, and circumstances surrounding the stranding. It also takes into account the evaluator's level of experience. If you have not conducted many evaluations or are not familiar with the region, you may be unable to make an accurate final evaluation.

For this section you are providing NOAA with a reliability estimate for the likelihood that human activities caused a stranding. Circle the most appropriate number. The higher the number, the more confident you are. If you do not feel that you can provide an evaluation, circle 0 – CBD.

0. CBD - Cannot provide an evaluation of the likelihood that human interaction caused the stranding.

1. Improbable - Unlikely that the stranding was caused by human interaction.

2. Uncertain - Possible that the stranding was caused by human interaction, but uncertain.

3. Probable - Very likely that the stranding was caused by human interaction.

4. Certain - Confident that the stranding was caused by human interaction.

43 Justification - Provide a brief justification of the answer for the *Final human interaction evaluation* score. Include information from all sources available to you. Use extra pages if needed, be sure to note the animal's field number on the top right margin.

Protocol for Examining Marine Mammals for Signs of Human Interaction

1 Field #: ____________________ Species: ____________________

2 Examiner: ____________________ Recorder: ____________________

3 Date of exam: ____________________ Condition code (at exam): 1 2 3 4 5 CBD

4 Preservation: alive fresh frozen frozen/thawed Body condition: emaciated not emaciated CBD

5 Documentation: digital print slide video Image disposition: ____________________

6 Integument: normal abnormal decomp/scaveng % Skin missing: <10% 10-25% 25-50% >50%

7 See *Explanation of terms* in instructions

	Whole Body Exam	YES	NO	CBD	NE	NA	Image taken (Y/N)
8	Head/appendages removed (w/ instrument)						
9	Pelt removed (w/ instrument)						
10	Body sliced (w/ instrument)						
11	Gear/debris present on animal						
12	Gear retained (name and contact info in *Comments*)						
13	External pathology (pox, tattoo lesion, abscess)						
14	Natural markings (scars, tooth rakes, odd pigmentation)						
15	HI lesions (fishery, gaff, gunshot, propeller, healed HI)						

16 Predation/scavenger damage (numbers coincide w/ anatomical areas below, circle those where damage hinders evaluation): 17 18 19 20 21 22 23 24 25 26 27 28 29 30 NONE

											Origin of Lesion									
							Type of Lesion				Gear						Other			
	Detailed Exam of Anatomical Areas	YES	NO	CBD	NE	NA	impression	laceraction	abrasion	other	twine/line	net	unknown	monofilament	multifilament	unknown	propeller	other	CBD	image taken?
17	rostrum/snout																			
18	mandible																			
19	head																			
20	R front appendage																			
21	R body																			
22	dorsum/dorsal fin																			
23	L front appendage																			
24	L body																			
25	ventrum																			
26	peduncle																			
27	R rear appendage																			
28	L rear appendage																			
29	flukes/tail																			
30																				

	Internal Exam	YES	NO	Partial	CBD	Image taken	Detailed Info (circle all that apply)
31	Internal exam conducted						Details in *Comments* section - use line number
32	Bruising/blunt trauma						Details in *Comments* section - use line number
33	Skeleton examined						Details in *Comments* section - use line number
34	Broken bones present						Associated tissue reaction: YES NO CBD
35	GI tract examined (circle contents)						intact prey partially digested hard parts only debris/gear empty other
36	Lungs/bronchi examined						Details in *Comments* section - use line number
37	Lungs/bronchi contents						froth fluid air (color:____________)
38	Other pathologies noted						Details in *Comments* section - use line number

Field #: ___________________________

39 **Comments** (note line number from left margin before each comment):

40 **Signs of Human Interaction Observed:** YES NO CBD (transfer to Level A Datasheet)

41 **Stranding Event History/Circumstances:**

42 **Final Human Interaction Evaluation**
If you circled YES above (#40), evaluate the external exam, necropsy, carcass condition and circumstances surrounding the stranding event to answer the following question:
What is the likelihood that the observed signs of human interaction contributed to the stranding event?
0: CBD 1: Improbable 2: Uncertain 3: Probable 4: Certain

43 **Justification:**

Index

Page numbers for figures are in **bold**, references to information in text boxes or tables are in *italics*.

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